Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY JANUARY 1995 $3.75/CANADA $4.75

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The World According to Scott Adams

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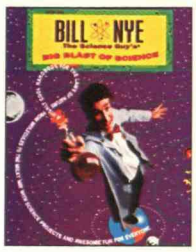

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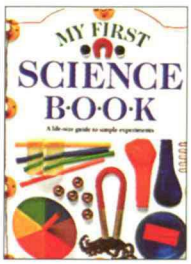

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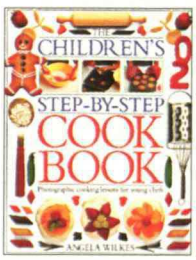

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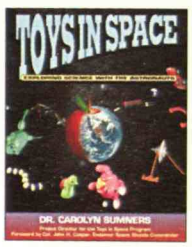

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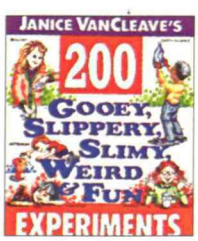

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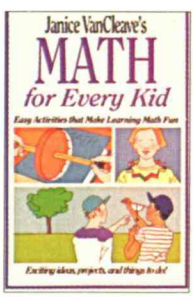

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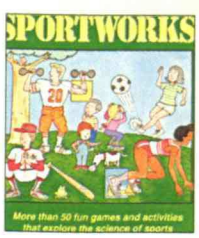

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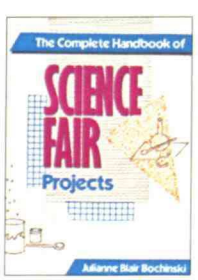

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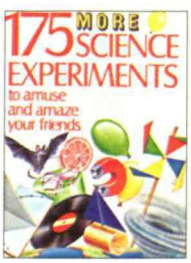

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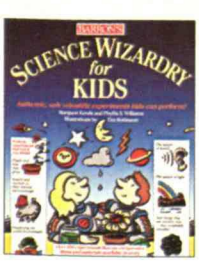

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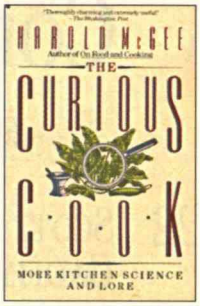
by Harold McGee



How can you keep the green in guacamole and pesto sauce? What's the best way to make fruit ices? Packed with fascinating scientific lore, *The Curious Cook* answers these questions and more to help the home cook make use of scientific discoveries about food.

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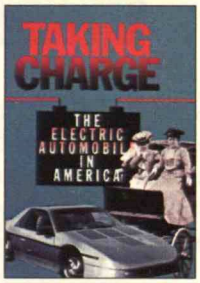

Discover the history and future promise of the electric car in America. This book revisits the race between electric and gas-powered cars in all its aspects, including the little known collaboration of Henry Ford and Thomas Edison. Schiffer suggests that for Americans it may be time for the fabled victory of the tortoise over the hare. *Hardcover, 224 pages, $24.00*

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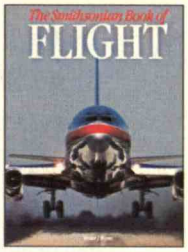
by Walter J. Boyne



The former director of the Air & Space Museum has composed this beautifully illustrated history of flight. It chronicles the rapid evolution of aviation technology, and focuses on the meaning of flight for the human spirit. A beautifully illustrated single-volume history.

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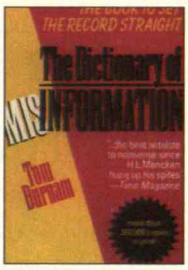

A remarkable book that contains enough information to help you win bets the rest of your life: London's Big Ben is neither a clock nor a tower, scores of people had flown non-stop across the Atlantic before Lindbergh, and no witches were burned at Salem.

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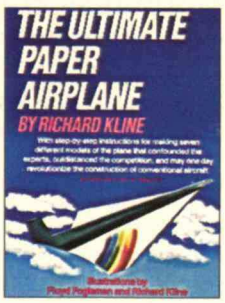

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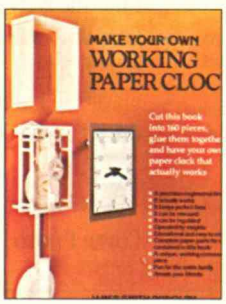

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JANUARY 1995

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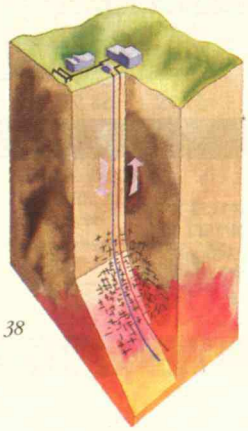

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TECHNOLOGY REVIEW
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Technology Review (ISSN 0040-1692), Reg. U.S. Patent Office, is published eight times each year (January, February/March, April, May/June, July, August/September, October, and November/December) by the Association of Alumni and Alumnae of the Massachusetts Institute of Technology. We welcome letters to the editor. Please address them to Letters Editor, c/o address below or by e-mail to: <technology-review-letters@mit.edu>.

Editorial, circulation, and advertising offices: *Technology Review*, Building W59, MIT, Cambridge, MA 02139, (617) 253-8250; FAX (617) 258-7264. Printed by Lane Press, S. Burlington, VT. Second-class postage paid at Boston, MA and additional mailing offices. Postmaster: send address changes to *Technology Review*, MIT, Building W59, Cambridge, MA 02139, or e-mail to <traddress@mit.edu>.

Subscriptions: $30 per year. Canada add $6, other foreign countries add $12. Contact *Technology Review*, P.O. Box 489, Mount Morris, IL 61054, (800) 877-5230 or (815) 734-1116; FAX (815) 734-1127, or e-mail to <trsubscriptions@mit.edu>.

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First Line

Beyond Horsefeathers

OKAY, okay. I'll admit it. We at *Technology Review,* as some readers have long suspected, are indeed Marxist-Lennonists.

In the sense first expressed, I believe, by Abbie Hoffman during the 1960s, we are Marxist not in the tradition of Karl but of Groucho, and Lennonist not after Vladimir but John. In the spirit of Groucho Marx and John Lennon, we try to present you not with orthodoxy and predictable discourse but with new ideas that are stimulating, skeptical of conventional wisdom, and filled with intellectual surprises.

We do not aim to convert you to any particular cause—our authors' politics in fact span a very wide range—but to sharpen your thinking wherever your own politics, opinions, and sympathies may lie. After all, if society is to develop and apply new technology, as well as adapt old technology, in the most creative and enlightened ways, we have to examine diverse and sometimes audacious options—including a few with which we may heartily disagree.

I am moved to say all this because of the many letters we received, most of them negative, in response to Gar Alperovitz's article, "Distributing Our Technological Inheritance," in the October issue. In a bygone TV commercial, the great mother of us all created a hell of a storm when confronted with a proposed substitute for good old-fashioned butter. "It's not *nice* to fool Mother Nature," she explained. Similarly, in the case of the Alperovitz article, it's obviously not nice to fool with the American Dream—or at least to be perceived as doing so. In this case, the reader stimulation we sought was actually irritating for most respondents, the intellectual surprises downright unpleasant.

Alperovitz questioned the traditional American belief that any person, if he or she is alert, astute, and persistent enough, should be allowed to grow rich virtually without bound. Observing that we all stand atop a Gibraltar of knowledge, accumulated over generations and contributed to by numerous people, and that this common inheritance provides most of the basis of present-day advances, he argued that the resulting wealth should be more broadly shared.

Letter writers were "aghast" at this "profound foolishness" and "crackpot social theory," and many deemed Alperovitz to be "waving the red flag of socialism." "Calling for the end of property rights," he would purportedly "strip all individuals of the products of their work and deliver it to the mob," "have the government firehose it to nonproductive purposes," and "terrorize freedom-loving people everywhere." Did you fail to notice, asked one reader, "that a similar idea just killed tens and impoverished hundreds of millions of people in its 70-year reign in the Soviet Union?"

Unconventional ideas are often the fuel of progress.

The author in fact neither said nor implied any of the above. Using the renowned Bill Gates, America's wealthiest individual (with a net worth, recently estimated by *Forbes*, of $9.35 billion), as an example, Alperovitz questioned whether the entrepreneur "should personally benefit *to such a degree*" (emphasis mine). He never said that Gates and others of his ilk shouldn't be rewarded for their accomplishments or shouldn't be rich.

Despite the irate reaction, Alperovitz's basic notions do not seem so radical to mainstream economists with whom I spoke. "It is standard," said Paul Krugman of Stanford University, "to try to regain for society [a good fraction of] some big private gain." Such an assumption "is built into the tax system, which is strongly progressive." And Lester Lave of Carnegie-Mellon University noted that society constantly wrestles with "pragmatic choices" on intellectual-property rights in its attempt to balance short-run gains to the innovator against long-run gains to the public. "Ask your readers," he said, "if they think we should make patents both broad and for eternity. Would they like to still be paying royalties to the heirs of James Watt for the steam engine?"

Some might well argue that capital should be exclusively controlled by a handful of elite private investors. But that's one kind of system, and an undesirable extreme, with the other being Soviet-style socialism. Surely there are numerous possibilities in between, with some potentially a lot more effective than any we've yet known. Just as technology innovators continually try to modify their designs to improve efficiency, reliability, and satisfaction for more and more users, why shouldn't creative people think about, and perhaps safely experiment with, economic ideas that might build on the present system to produce big improvements and greater opportunities for more potential entrepreneurs?

In any case, the Alperovitz article was not a call to action but a "think piece," aiming to stir readers' imaginations. In that goal it clearly succeeded, maybe too well. But we at *Technology Review* cannot dismiss the responses as merely visceral; they included plenty of legitimate criticism. And we must take both types of reaction seriously. Editors are supposed to stay slightly ahead of their readers, lest they bore them with what they already know; but editors must also avoid getting too far ahead of—or simply out of tune with—readers, which can disorient, annoy, and lose them.

Even Groucho Marx and John Lennon occasionally failed to please their audiences. In show business parlance, they could "lay an egg"—they sometimes "bombed"—for the simple reason that they regularly took risks and tried to push the limits of their craft and material. That chutzpah was what, most of the time, deeply satisfied the audience and led to a devoted following. At *Technology Review,* we try to innovate—and learn—in that spirit. ■

—STEVEN J. MARCUS

Letters

JUST REWARDS

In "Distributing Our Technological Inheritance" (*TR October 1994*), Gar Alperovitz (correctly) lauds Albert Einstein for recognizing the value of his predecessors' work. But he then marches straight-away into a fog by concluding that "in fact, very little of what [Einstein] produce[d] can be said to derive from [his] work, risk, and imagination." Though Alperovitz states that our accomplishments stand "atop a Gibraltar of technological inheritance," he either intentionally omits or fails to perceive its logical twin: "Michael Jordon's athletic accomplishments stand atop a Gibraltar of genetic inheritance." Inequality is the inevitable result of humanity's genetic lottery.

The equal distribution of capital that Alperovitz clearly advocates is, fortunately, unachievable. Equal opportunity will necessarily yield unequal results since we are endowed with diverse abilities, drives, characters, and predilections. To seek equal results through force is antithetical to our country's founders' vision of life, liberty, and the pursuit of happiness.

MARK D. HEAD
Dallas, Tex.

In my experience in a career in R&D, product development, marketing, and management, technological edge is seldom the determining factor in the success of a product or a company. The reward—market share or profit—goes to the organization that can put everything from technology and manufacturing to sales and marketing together. If someone can understand and implement all the essential elements, why shouldn't he or she reap and keep the rewards?

Gar Alperovitz's plan to raise inheritance taxes will severely diminish incentive to create anything. Even today's socialist societies are dispensing with high taxes, rules, and regulations in an effort to become more competitive.

WILLIAM TARASEN
Santa Fe Springs, Calif.

"Distributing our Technological Inheritance" strives to portray itself as a proposal outside of the realms of traditional socialism and traditional capitalism. I heartily agree that it falls outside the latter, but I am having greater difficulty seeing how it falls outside the definition of traditional socialism. Alperovitz simply proposes another formula for redistributing wealth to those who have not earned it.

Certainly the exploration of our debt to our technological inheritance is a laudable avenue of thought that ought to be plumbed by those gifted enough to effectively build on that inheritance. Indeed, I will grant that in cases where individual wealth is directly built on government-funded innovations, a scheme whereby the "government of the people" can receive royalties to reinvest in research is reasonable. In a broader sense, people who build on the hazily definable mountain of pebbles ought themselves to make contributions to the community and to further technological advance, but ought not be compelled to by government or any other power.

BOB MASON
Santa Clara, Calif.

I have some disturbing news for Gar Alperovitz. Communism's dead.

ALAN KRIGMAN
Philadelphia, Pa.

I was aghast to read "Distributing Our Technological Inheritance." Our inheritance tax is already quite high. When Bill Gates goes to his reward in the great beyond, and presuming he doesn't turn his fortune over to a nonprofit organization such as MIT, the government will take 55 percent, or $4.4 billion, of his $8 billion. Not a bad haul. His heirs won't be poor, but it would be difficult to say that a significant redistribution hadn't taken place. Further, to conclude that funds from those estates would be put to better use if the government appropriated them is not readily apparent to most of us who have been observing the government's ability to spend more than it takes in.

LARRY R. WAGNER
Fort Bragg, Calif.

As both business executive and investor, Bill Gates has demonstrated extraordinary skill in selecting, developing, and nurturing products, services, markets, *and people*. In this endeavor, he has created 15,000-plus direct jobs (for Microsoft employees) and at least that many indirect jobs. Because Microsoft is a multinational enterprise, nearly everyone on earth benefits from Bill Gates's entrepreneurial skills—in particular, Microsoft's stockholders, employees, suppliers, and customers. Now, *that* is wealth distribution on a massive scale. Incidentally, Gates has publicly pledged to give away most of his personal wealth and bequeath "only" a few million to any offspring who survive him.

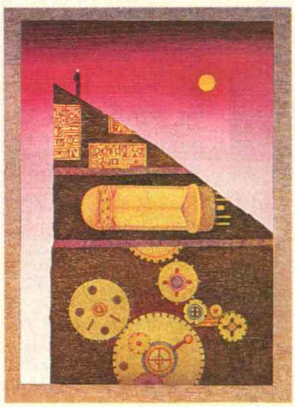
History teaches that it is government-directed wealth redistribution that is inherently "irrational and unjust." Communal ownership of capital has a spotty record, too. Historically, collectivism yields corruption and tyranny while free markets yield the greatest prosperity for the greatest number.

DAVE NELSON
Corvallis, Ore.

Gar Alperovitz's theme is that "all citizens should share in the benefits of a common and prodigious legacy," which he identifies as the aggregate collection of knowledge. But we already share this legacy. Bill Gates's fortune has not been obtained at the expense of others, as Alperovitz implies. Rather, Gates has added greatly to our general wealth with a clever marketing plan that effectively created a standard operating system for personal computers. This standard has spawned inexpensive software that has profoundly eased the burdens of many professions, including my own (law).

MARK RILLINSON
Leesburg, Va.

A resounding cheer for Gar Alperovitz's clear-eyed discussion of why we are morally obligated to distribute our technological inheritance and how that might happen. His ideas will infuriate people who insist that all good individual outcomes are achieved through hard work, wise investment, and careful household management, but his figures and logic are hard to refute. In a world where "smart machines" and globalization are steadily undermining developed nations' traditional dependence on large numbers of human workers, it is of the utmost importance to make clear, as Alperovitz does, that it is social investment (use of taxpayer money) in health, education, law and order, R&D, and infrastructure that has largely made possible the private accumulation of wealth.



We must find ways to recover and redistribute the vast wealth created by the commercialization of information technologies now and biotechnologies in the future. This is a challenge, not an impossibility, and failure to achieve the goal will leave us open to the sort of political strife that no number of prisons can contain. Alperovitz might have noted that we have only limited lead time to create more equitable societies, in the name of enlightened self-interest as well as of justice, before we face the stark possibility of a bladerunner world.

SALLY LERNER
University of Waterloo
Department of Environment
and Resource Studies
Ontario, Canada

I applaud *Technology Review* for raising the important question of what economic alternatives may lie beyond corporate capitalism and state socialism. The emotionally charged competition between these two dominant systems has tended to obscure their common foundations in nineteenth-century industrialism and its legacy of environmental degradation and social ills that now threatens the planet. Alperovitz's criticism of the "irrationality of the present economic system" may easily stir conditioned reflexes in protection of a system no longer threatened—except by itself. As Alperovitz points out, we are finally beginning to hear of some alternatives to taxing and slashing in solving problems in education, health care, crime, and homelessness. The experiments in employee and community ownership and public investment he refers to deserve much closer examination.

As we move deeper into the postindustrial age of globalized transfers of money, patents on genetic manipulations, automated factories, ecological devastation and depletion of resources, and a world economy dominated by transnational corporations with budgets larger than those of many nations, perhaps it is time to rethink our definitions of wealth, property, work, and inheritance. Instead of holding old concepts sacred, it behooves us to start determining what really *is* sacred.

JEFFREY BARBER
Integrative Strategies Forum
Washington, D.C.

It seems "irrational and unjust," Alperovitz says, that our society should permit a class of privileged citizens to grow whose advantages derive solely from the luck of the draw at birth and not from their own talent and hard work. Yes, indeed. Bravo! It is precisely the energy of individual entrepreneurs, creators, and innovators, motivated often by the hope of achieving great honor or wealth, that drives this democratic free market he wishes to tear down. Strange that he should twist the value of individual initiative into a call for leveling and state-imposed mediocrity.

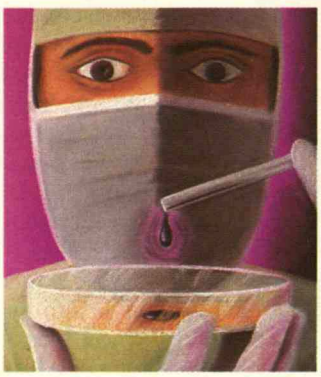
Bill Gates owes none of us a red cent. Some in the business have questioned his style and the ethics of some of his dealings. These are separate issues that

can be fairly debated. None, however, doubt the drive and determination and brilliance of the man who has helped create an industry that employs thousands and provides vast benefits to the whole of society. So he's garnered $8 billion and counting. Fine by me. More power to him. We should all be so lucky.

William Cooper
Chicago, Ill.

THE PROPER STUDY OF VIOLENCE

Much of Jane Ellen Stevens's article "Treating Violence as an Epidemic" (*TR August/September 1994*) is sheer nonsense and conjecture unhindered by fact. Just because one uses medical terms like "epidemic" and "prevention," it does not follow that the nature of and reasons for violence have somehow miraculously changed. The article fails to note a single instance where this new approach has materially reduced violent acts.



Also, the article claims that from 1975 to 1989, when prison terms tripled, crime rates increased. But I have seen other statistics that demonstrate the opposite: as jail time decreased for crimes, many repeat offenders returned to the streets, where they committed violent crimes again.

It is time we faced the fact that the breakdown of social structures is the major contributor to violence. I would prefer a community that has high moral standards, strict laws, and swift punishment for crimes over one that promotes understanding and counseling.

RALPH T. SOULE
Bremerton, Wash.

How odd that automobile accidents don't qualify for the new approach to studying violence. But then, hardly anything does—evictions that make families homeless, plant closings accompanied by the end of pension plans, and the release of toxic substances on an unsuspecting public are all outside the new purview. Violence, as defined by government and independent "experts," occurs mainly among the poor and results from drugs, poor upbringing, or some mixture of the two. The "violence as an epidemic" concept is determined to ignore about 99 percent of the violence and violent institutions in the world today.

TERRY SCOTT
Seattle, Wash.

Because alcohol is closely linked with violent behavior, banning alcohol advertising on radio and television would seem reasonable. After all, the beliefs of children are shaped to no small extent by what they see daily on television. The law might be similar to the one passed in 1971 banning cigarette advertising in the name of reducing tobacco-related morbidity and mortality. However, after spending years trying to convince our legislators to do so, I can only report with sadness that our Washington lawmakers seem to have no desire to place the health and lives of our youth above the private interests of this nation's alcohol and broadcasting industries.

CYRUS J. STOW
Conyers, Ga.

Stevens seems to studiously avoid the issue of gender. Yet gender can be read in the author's mentions of violent crime statistics: "rape per 100,000 women" and "female abuse by male partners" (which is so common that it is listed per 1,000 couples as opposed to the per 100,000 scale for other crimes). Also, the violent Dutch family members Stevens cites appeared to be all males. In spite of this, her only reference to sexism is in a laundry list of possible causes of violence.

While *some* women do perpetrate violence, and *some* men do not, we are largely talking about a male problem. And in approaching the problem socially, politically, *and* biologically, an analysis of gender (including feminism, patriarchy, and male culture) is essential.

BETSY SALKIND
New York, N.Y.

To blame crimes of violence on the ownership of arms by law-abiding citizens is like blaming intravenous drug abuse on the possession of hypodermic syringes by insulin-dependent diabetics. If, as the article states, the Center for Disease Control and Prevention has "almost no information about what works and what doesn't work" in preventing violence, how can we be so sure that gun control is the answer? It is easy to demonize an inanimate object when we need to undertake the real and unpleasant measures necessary to turn back the rising tide of violence.

JOHAN P. BAKKER
West Bloomfield, Mich.

In pointing out that some communities are less violent than others, Jane Ellen Stevens fails to draw the conclusion that individual regard, personal respect, self-esteem, a strong code of personal responsibility and community service, and other positive values are central factors in preventing violence. Violence prevention has also been linked to the institutions that help define our communities such as our schools, universities, hospitals, local businesses, churches, and government. If these entities teach or exemplify callousness, indifference, disregard, and uncaring attitudes, then these negative values are transmitted to the community. This is why *Healthy People 2000*, which sets national goals for health promotion activities and disease prevention to be met by the turn of the century, treats violence as a public-health issue.

Violence-prevention strategies are cheaper and more effective in the long run than incarceration that costs up to $100,000 per inmate and entails terrible loss of life.

LOUIS W. SULLIVAN
President
Morehouse School of Medicine
Atlanta, Ga.

Continued on page 70

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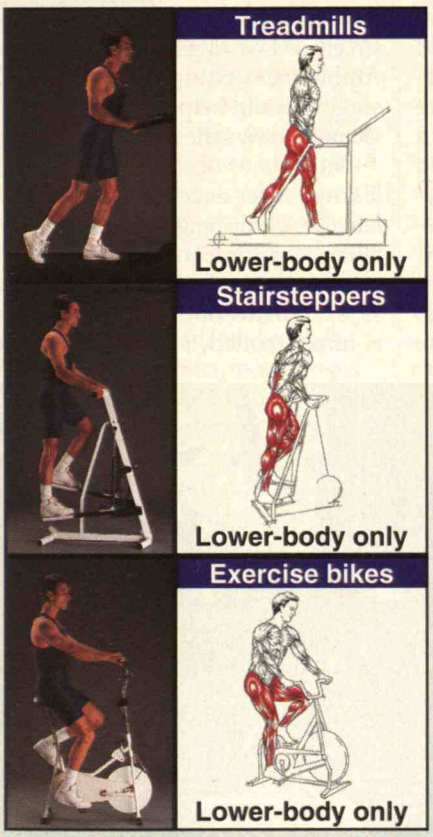

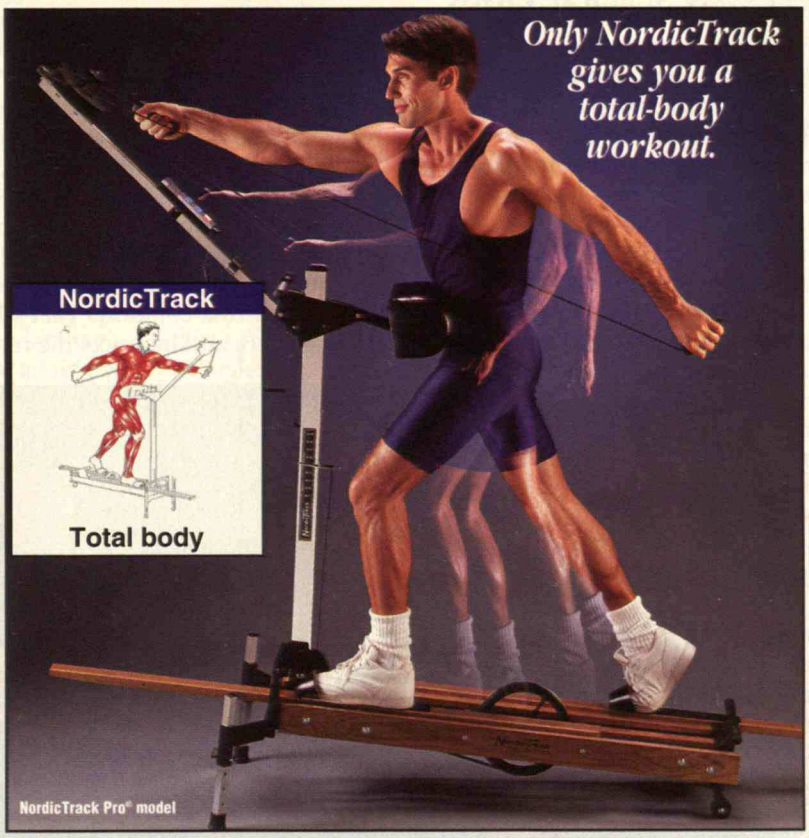

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MIT Reporter

A Cure for Surgical Chaos

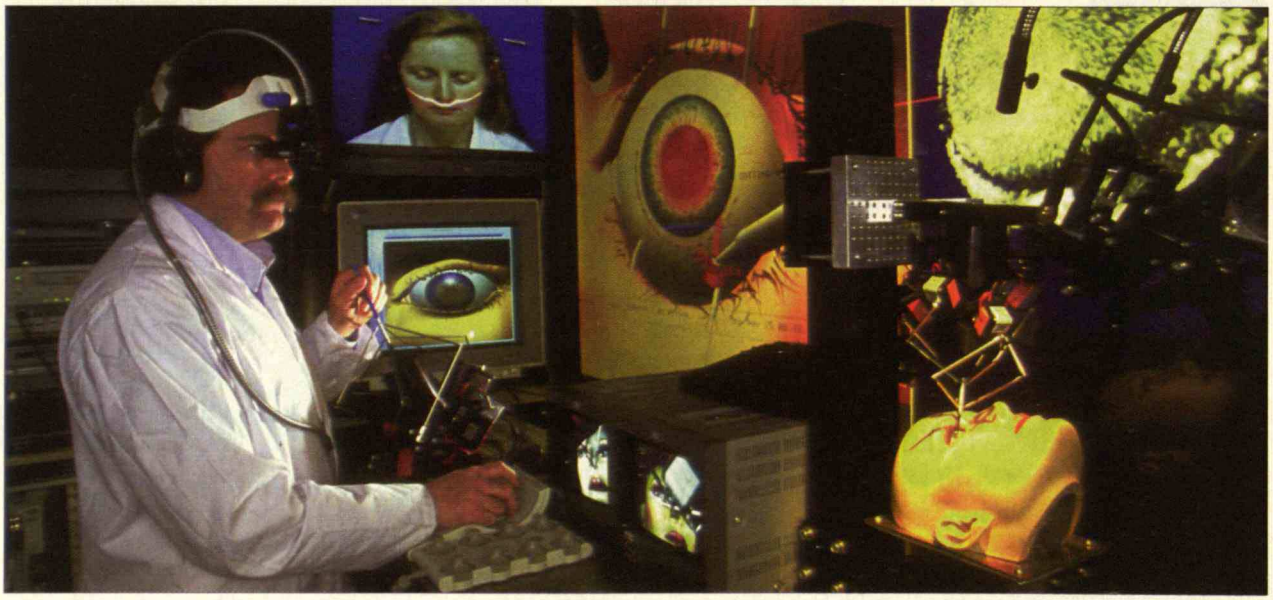
The first time Kenneth Kaplan walked into a typical hospital operating room, he was alarmed by the working conditions. Tangled wiring, unvented smoke, stacks of monitors held together with masking tape, people tripping over cords. "It's quite a hostile environment," he concluded. Today Kaplan, an architect with a joint appointment in MIT's Department of Architecture and Research Laboratory of Electronics, is coordinating an ambitious five-year program sponsored by the Advanced Research Projects Agency (ARPA) to redesign the often chaotic surgical environment. What began as a project aimed at saving lives on the battlefield has broadened into an effort to create the "operating room of the future," a compact and efficient unit that can gradually incorporate tomorrow's surgical technology without turning into a jumble of incompatible equipment.

Kaplan's involvement in the project began two years ago, when Col. Richard Satava, an Army surgeon and manager of ARPA's Advanced Biomedical Technology Program, asked him to figure out how to fit high-tech surgical equipment into military ambulances. Satava's scheme was, and still is, mind-boggling. The plan is to develop telerobotic technology that will enable surgeons at field hospitals to perform emergency procedures on wounded soldiers as they are being evacuated. In the ambulance, a bank of instruments will cut, laser, and suture, all under the control of the distant surgeon, who will view the procedure through a head-mounted display. The surgeon will manipulate a set of tools wired to a computer that senses every gesture and instructs the remote surgical tools to move accordingly. ARPA has already demonstrated a crude mockup in which a prototype telerobotic apparatus was used to truss assorted chicken parts.

In keeping with its much heralded commitment to dual use, the agency also envisions a civilian version of the system. "After all," says Kaplan, "the statistics are that it's more dangerous to be in the streets of Los Angeles than in Somalia." Ambulances equipped for telerobotic surgery could help accident or gunshot victims survive the trip to the hospital.

But a major obstacle, as Kaplan soon learned after accepting Satava's challenge, is equipping the hospitals where telerobotic surgeons will be based. "The standard operating room is a mess," he says. "The technology infusion into it is uncontrolled, and there's no room for yet another big, complex system." Kaplan quickly realized that ORs need an overhaul whether they are used for remote surgery or not. So while other participants in the ARPA project—such as Ian Hunter, an associate professor in MIT's Department of Mechanical Engineering—pursue telerobotic surgical systems, Kaplan is starting design work on an OR that will accept such new technologies smoothly and seamlessly.

A possible guinea pig in Kaplan's experiment is Massachusetts General Hospital in Boston, which has participated in early planning of a prototype OR. Within three to four years, he says, MGH may host a new "modular" surgical unit that Kaplan compares to the Nikon camera system: "You



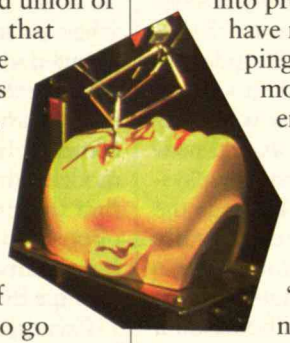
Manipulating the "master" tool of his telerobotic eye-surgery system, Ian Hunter controls the "slave" unit above the mannequin. The projection screen in the center displays 3D images—either a computerized "virtual environment" of an eye, as shown, or images from the stereo cameras at far right. A head-mounted stereo microscope (not part of the telesurgical system) lets Hunter examine the mannequin close up.

PHOTO: SERGE R. LAFONTAINE, TILEMACHOS DOUKOGLOU

buy the body and add on the lenses you want." Once surgeons have tested it at MGH, the unit will be manufactured and sold as a kit of parts that can be configured according to a hospital's needs. The surgical unit Kaplan envisions will be portable enough that it could fit into an existing room at a civilian hospital or be adapted to military trucks, helicopters, submarines, or tents.

What will the surgical room of the future be like? For starters, it will incorporate Kaplan's favorite design principle: integration. "A hospital is really layers and layers of unintegrated systems on top of each other," he says. A major symptom of this condition is the proliferation of specialized operating rooms. "Every time a new procedure is invented," says Kaplan, "a hospital has to build another OR." MGH, for example, has 45 different operating rooms, each devoted to a surgical specialty. Kaplan wants to "create one OR in which 45 different procedures can occur."

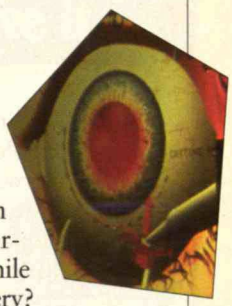
To smooth the integration process, ARPA has enlisted the aid of Northrop-Grumman, the newly formed union of two aerospace companies that have considerable experience in tying together components from different sources. Northrop-Grumman's B-2 stealth bomber, says Kaplan, contains more computer systems than the space shuttle. "The B-2 people act as 'general contractors,' and if you want your equipment to go into their cockpit, you had better conform to their specs," he says. This approach enables aircraft builders to upgrade their planes by plugging in modular equipment instead of redesigning the cockpit. But medical equipment suppliers "have never been forced to work together the way aerospace companies have," says Kaplan. "Aerospace people who've looked at surgical rooms say these rooms are now where cockpits were 30 or 40 years ago." One of Northrop-Grumman's tasks will be to develop "generic specs" to ensure that equipment for the new surgical room is compatible and easily updated.



Kaplan also hopes to solve some nagging ergonomic issues that hospitals have never fully addressed. "For example," he says, "the problems of lighting are quite dramatic." Surgeons need intense task lighting for cutting tissue, says Kaplan, but their approach has been to use crude clamp lamps that reflect off tissue and cast shadows, with the unpleasant result that "the surgeon has to reach out with a bloody hand and adjust the light." Expect to see robotic lighting systems that respond to the surgeon's voice, hand gestures, or eye blinks.

Another area begging for reform is the visual display of information. Today's racks of monitors are often widely separated and hard to see, says Kaplan. "The surgeon has to ask the anesthesiologist for a readout, and often must crane to view TV monitors displaying medical imaging." Kaplan would bring even more information into the operating room—patient records and textbook excerpts, for example—but display it in a more accessible way. He's looking into providing large screens that have multiple windows, equipping surgeons with head-mounted displays, or even embedding display screens into the operating table.

And while he's on the topic of tables, Kaplan has a few grievances that he'd like to redress. "There's all this stuff underneath. There's no place to put your feet. There's no place to sit. The table has never been designed—it just sort of exists." Using composite materials would make the surgical table lighter and more flexible, he says, and padding the surface with electrorheological fluid—material that changes from liquid to solid with an electric current—would allow the table to conform better to the patient's body. In fact, Kaplan is thinking these days, why not go all the way and equip surgical tables with telecommunications so patients can receive words of reassurance from loved ones while waiting to go in for surgery?



Reach Out and Stitch Someone

As telerobotic surgical technology matures, the operating room will be transformed further still. This part of the equation is the province of mechanical-engineering professor Ian Hunter, whose laboratory is designing computer-based "virtual environments" that will give tomorrow's surgeons unparalleled control over their instruments. Hunter's virtual environments are digitized maps of the body part on which the surgery is to be performed. They include not only visual data—allowing the physician to view the surgery on a computer monitor from any angle or distance—but also data on the mechanical properties of the tissues being operated on.

Seated in front of a monitor, the surgeon will manipulate a "master" unit, a set of tools that translate hand motions produced on a human scale into exquisitely fine gestures (a thousandth or even a millionth the size of the original) executed by a robot "slave" unit above the patient. Thanks to the tissue-mechanics data stored in the virtual environment, the master instruments will provide "force feedback"—a physical sensation of resistance that helps the surgeon gauge how hard to press. Hunter's group has built a prototype virtual environment for eye surgery and is working on another one for the heart.

Although Hunter's immediate aim is to enhance surgery where practitioner and patient are both in the same room, he says it is only a matter of time before telerobotic surgery becomes feasible over long distances. His wife, Lynette Jones, a principal research scientist in the Department of Mechanical Engineering, is studying the effect of delays in visual and force feedback—an irksome artifact of telecommunications—on a

surgeon's ability to operate. She says it may be possible to compensate for time lags with software that predicts changes in the mechanical properties of tissues as the surgeon cuts.

Even before they find their way into the surgical room of the future, however, virtual environments will play a crucial role in the room's design. "The same tools that you use to create virtual environments of organs can be used to create virtual environments of operating rooms," says Hunter. For example, the lasers that rapidly scan a patient's body to determine its geometry can just as easily scan a room and its contents and feed the measurements into a computer so designers can begin moving things around on screen. Kaplan is working with Hunter and with Nathaniel I. Durlach, a senior research scientist in MIT's Department of Electrical Engineering and Computer Science, to develop a virtual environment where prospective users can sit before a computer display of a surgical room and adjust conditions such as lighting and airflow, manipulate surgical tools, and generally get a feel for the layout. Over the next five years, the researchers expect to generate dozens of possible room designs tailored for different settings.

Kaplan recognizes the dangers of dispensing high-tech solutions in a milieu that is often accused of being too quick to adopt expensive cutting-edge technologies. But his defense is simple: a well-designed, well-integrated surgical room can save hospitals money. In today's haphazard approach to surgical facilities, he explains, "a doctor comes along and says, 'Hey, I've got a great idea,' the hospital buys a new system, they put it in the room, it doesn't work, they put it over to the side, and then they come in with another system. We're offering to gate-keep these technologies." The virtual-environment design tool, he says, will also allow hospitals to avoid costly mistakes at the planning stage.—*DAVID BRITTAN*

To view this article with interactive links to additional sources of information, visit our World-Wide-Web server at <http://web.mit.edu/afs/athena/org/t/techreview/www/tr.html>.

To settle a long-standing controversy over the net effects of seawalls on erosion, Ole S. Madsen is using a computer-controlled wave-making system to simultaneously pound the same kinds of waves against a sandy beach (left) and a seawall-protected "shoreline" (right).

RULING THE WAVES

Sandy beach and ocean waves may sound like the perfect ingredients for getting away from work, but inside a nondescript, yellow-brick building at MIT they are the stuff of cutting-edge research. There, in a 60-by-40-foot water-filled basin, as many as 47 flat, computer-controlled paddles independently move back and forth at varying speeds to create the complex wave patterns found on the high seas and near shorelines. Engineers are using the system, one of only four such basins in the U.S. that can closely mimic naturally occurring waves, to study flood-protection plans and improve climate models.

Consider the potential impact on a $2 billion effort to protect Venice from the seawaters that flood the city about 50 times a year, sometimes soaking people to their knees. In the early 1980s the city, along with Italy's Ministry of Public Works, developed a plan for installing gates across the bottom of three Aegean Sea inlets as a defense against rising storm waters. Under the plan the gate, composed of closely fitting steel boxes, would rise into place when air in an underwater pipeline is pumped into the boxes. Unfortunately, when researchers at Delft Hydraulic Laboratory in the Netherlands and the company Estramed S.P.A. in Rome each modeled the system in 1988, they found that the steel boxes could oscillate in opposite directions when battered by certain kinds of waves, allowing water to surge through.

Creating one very long box for each inlet is no solution, since the waves' force would act as a "huge hammer" on the seabed-fixed axle holding the boxes together, creating so much torque that the setup would collapse, explains Chiang C. Mei, professor of civil and environmental engineering. With multiple small boxes, the wave force is equivalent to a number of little hammers, which the axle can withstand. Mei is using the MIT wave basin to learn why the proposed

PHOTO: MARK OSTOW

device can behave erratically. Engineers could then resolve the problem.

By relentlessing bombarding a model of a Venetian seagate with the waves that the Delft and Estramed researchers identified as problematic, Mei has found that such waves can become trapped near the gate, resonating in a way that sets the boxes swaying. Based on this research, Mei is now trying to develop a theory that could be used to determine box dimensions and buoyancy levels that prevent this phenomenon and the resulting rupture.

Surf's Up

While Mei concentrates on efforts to preserve a unique cultural heritage, Ole S. Madsen, another professor of civil and environmental engineering, is trying to resolve a long-running controversy over whether seawalls—piles of rock commonly built to protect beach dunes—actually do more harm than good. While property owners often want to erect such walls on beaches subject to storms each winter, many officials in state coastal zone management programs maintain that walls can actually worsen erosion as crashing waves dig away sand in front of the structures as well as on either end. Property owners and coastal officials point to conflicting studies of erosion loss to buttress their arguments.

The studies differ because they "have not considered all aspects of the problem," particularly "the true net loss" of sand, Madsen says. Therefore, he and his graduate students are running a thorough wave experiment on a seawall and an unprotected sandy shore. The group has built two seven-foot-wide beaches in the MIT tank, one consisting solely of sand and the other supporting a rock wall with sand in front and back. The team is simultaneously pounding the two sites with large, head-on waves like those that occur during winter storms, then sending in long, gentle swells typical of summer, which tend to return some sand. After simulating a year's worth of waves in only a few hours (the waves are programmed to have shorter periods than those that occur in the ocean), the group is measuring changes in water depth—an indication of how much erosion has occurred—to determine which beach has lost more sand.

Heidi M. Nepf, an assistant professor of civil and environmental engineering, plans to use the tank to simulate waves that break in the middle of the ocean whenever wind speeds reach about six miles per hour. A better understanding of how breaking waves pass the wind's momentum to the sea, and of the accompanying heat and carbon-dioxide exchanges between atmosphere and ocean, could help improve climate models.

Nepf says that unlike many basins, the MIT system can create a wave that breaks in a way that "really mimics what happens in nature," complete with whitecaps, in a predicted location in the tank. As her experiment starts, the water will include a top layer of dye consisting of a chemical that fluoresces under laser light. A tiny cylindrical lens will spread laser light in a wide, vertical sheet as a wave breaks in the darkened room. A camera trained on this location will record, at 30 frames per second, movement of the dye. By examining the frames, Nepf's team will gather information about how the dyed region spreads over time. Nepf also plans to measure the velocity of the turbulent water and hopes to examine what happens to such areas when successive waves break.

There's virtually no end to the projects that can be conducted in tanks that can replicate natural ocean waves, points out James Houston, director of the Army Corps of Engineers' Coastal Engineering Research Center in Vicksburg, Miss. Mei agrees. Like a piano, he says, the setup "can play all kinds of tunes." Because engineers haven't developed computer models sophisticated enough to simulate actual conditions in the world's oceans, the handful of accurate U.S. tanks—and another few in Europe and Japan—are in constant use for research as well as for designing harbors and offshore platforms.

—*LAURA VAN DAM*

Trends

Less-Than-Lethal Weapons

A drug dealer running from police down a city street grabs an elderly woman, puts a knife to her throat, and screams at pursuing officers to back off. A brawling drunk in a neighborhood bar breaks a bottle and attacks an advancing patrolman called in to break up the fight. Riotous protesters outside an abortion clinic scuffle with police as the protesters push toward the clinic doors.

In each of these scenarios, police officers are limited to three courses of action: they can try to convince the offenders to cease and desist, hit them with night sticks, or shoot them. Sadly, talking to individuals who are out of control rarely works. Thus officers must usually resort to force. But force can harm the alleged perpetrator, bystanders, and the officers themselves. It also leaves cops vulnerable to lawsuits for excessive use of force, which are increasing drastically. In fact, a single judgment can cripple a municipality's law-enforcement budget.

"Sticky foam," the latest in a new class of law-enforcement weapons, can be sprayed from a shoulder-slung canister to temporarily disable, rather than injure, an offender.

What officers need instead is a means to temporarily stun a suspect or constrict his or her movement so they can maneuver quickly to gain control of the situation. Unfortunately, most police weapons aren't designed to do that. "The tools of the trade haven't changed much since the late 1800s," says Steven Bishop, chief of police in Kansas City, Mo. "We're basically limited to the same options that Wyatt Earp had."

That may finally change. An initiative at the U.S. Department of Justice and efforts by several national labs are now aiming to address this problem by producing a new arsenal of less-than-lethal weapons for law enforcement, many adapted from military technology.

Most of the prototype devices aim to buy a few seconds for intervening officers without damaging the offender's body or senses. That goal represents quite a leap from the average military weapon. "When military force is applied, some loss of life, while not desirable, may be accepted as a reasonable risk," says John Alexander, manager of nonlethal technologies at Los Alamos National Laboratory. "In law enforcement, the acceptable risk factor must approach zero."

In one effort to develop "safer" weapons, engineers at Sandia National Laboratory have designed a gun that sprays a thin stream of glue-like polymer foam. When it hits a suspect, the sticky, coffee-colored goo expands rapidly, binding the person's hands, arms, and legs so he or she cannot use a weapon or continue to resist police. Foam systems could also be installed in prisons to restrain rioting inmates.

Los Alamos is working on an infrared CO_2 laser that heats the skin enough to cause pain, so a suspect would drop a weapon such as a knife held to a hostage's throat; the beam's power is limited so it doesn't burn the skin.

Similarly, the lab is developing an argon laser beam bright enough to temporarily blind suspects in daylight but not so intense as to damage the eyes. When the beam is aimed at windows, automobile windshields, or airplane canopies, microabrasions in the glass scatter this particular wavelength of light turning the entire sheet a glaring, opaque green. This weapon could prevent a high-rise sniper from seeing a target, a driver from speeding away, or a pilot on a suicide mission from aiming a plane at the White House.

The lab has also built what might be called an optical hand grenade, secured in a flashlight-like canister. When activated, an explosive charge sends a shock wave through xenon gas enclosed in the canister. The excited gas instantly re-emits almost all the explosive energy as light just as a fluorescent bulb re-emits electric energy, creating a glow so intense it can blind an angry crowd for as long as 30 seconds, enough time for police to establish barriers or maneuver other defensive equipment such as fire hoses.

Donna Marts, an engineer at the Idaho National Engineering Lab, has developed a back-seat air bag for patrol cars that pins down aggressive passengers. A surprising number of handcuffed offenders placed in the back seat of a patrol car become violent once the car is moving, trying to kick out doors or windows so they can escape. Suspects often harm themselves, damage the car, and even get killed if they succeed in jumping.

Marts devised an air bag that can be installed in the ceiling above the back seat. When the driver activates the bag, it quickly inflates and holds the passenger in check. To prevent offenders from suffocating, air is continuously pumped into and through the porous bag.

Marts has also designed a retractable barrier strip to stop cars during high-

PHOTO: SANDIA NATIONAL LABORATORY

speed chases. The flat strip is rolled like a hose and stored in a police car's trunk. Officers up the road from fleeing suspects pull the strip across the pavement and allow regular traffic to pass. When the offender approaches, the officer pushes a button and spikes lying flush in the strip pop up by means of a mechanical linkage. The spikes are hollow so they puncture the tire but do not tear it, causing a flat but not a blowout. The spikes quickly retract, allowing pursuing police cars to pass.

Although such nonlethal weapons are promising, a number of engineering challenges remain, not the least of which will entail reducing their cost. For example, Jon Meier, a program manager for nonlethal technologies at Los Alamos, points out that the rifle and power pack designed to emit a blinding beam of light currently costs the equivalent of a couple of police cruisers.

"We need economies of scale to make new technology affordable to law enforcement," says David Boyd, director of science and technology at the National Institute of Justice (NIJ), part of the federal Department of Justice. Along with the Department of Defense, the NIJ jointly funds several R&D programs in less-than-lethal technologies, including the work being done by Marts. "Unfortunately, the market is small," he says. "There are 17,000 law-enforcement agencies in the United States, but 90 percent of them have fewer than 24 employees."

To address such issues, the recently passed crime bill establishes a Law Enforcement Technology Center at NIJ, and the current House Armed Services Committee's appropriations bill would award NIJ $41 million in 1995. The center will conduct research, set design standards for new devices, and test equipment developed nationwide. It will also try to create market demand by identifying consumer product niches that use similar technology, and lending technical assistance to companies to design products with both commercial and police applications. Modified laser devices, for example, could be sold to the entertainment industry for laser light shows and theater productions. A technology transfer office within NIJ was scheduled to be open by the end of 1994.

Meanwhile, one low-tech weapon has already been adopted. Officers in the Kansas City Police Department carry pocket canisters containing pepper gas, an inexpensive form of chemical mace made with condensed capsaicin, the active ingredient in hot chili peppers. The spray causes a temporary burning sensation in the eyes, nose, and mouth so severe that suspects cannot open their eyes as they attempt in vain to wipe the chemical free. "Officers rave about it," says police chief Bishop. "It blinds perpetrators and often knocks them to the ground," allowing officers to get cuffs on them without resorting to force.

The "laser dazzler," a gun that fires an argon laser beam, turns windshields a glaring opaque green (top) to prevent offenders from driving away. A backseat air bag for patrol cars (bottom) immobilizes violent passengers.

When first armed three years ago, Bishop's 1,200-member force used the pepper-gas spray about 33 times a month. Now that word of the caustic weapon has spread to the street, use has dropped to 13 times a month, and injury and wrongful-death suits have decreased. "People aren't fighting the officers when they see the pepper gas," Bishop says. "They yell, 'Don't spray me with that stuff, man, I'm giving up!'"

—MARK FISCHETTI

PHOTOS: LOS ALAMOS NATIONAL LABORATORY

The Hunt for Black Holes

For decades, black holes have loomed as one of the most bizarre predictions of astrophysics. A vortex of gravity so powerful it can swallow up whole stars, a gravitational trap in whose inviolable clutch nothing, not even light, can escape, a black hole's very eccentricities make its detection as frustrating as the prospect of its existence is intriguing.

But recently, with images taken from the orbiting Hubble Space Telescope, the idea of a black hole inhabiting the center of a galaxy moved from theory one giant step closer to scientific certainty.

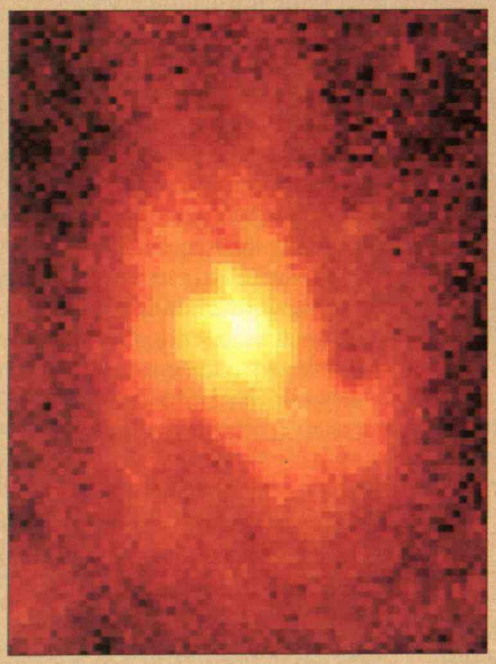
Peering deep into the heart of galaxy M87, some 50 million light-years from earth, Holland Ford, an astrophysicist at Johns Hopkins University, and colleague Richard Harms at the University of California at San Diego, found impressive evidence for a black hole as they watched a tremendous swirling pancake of interstellar gas—500 light-years in diameter—rapidly accelerating toward a giant gravity well at the galaxy's core.

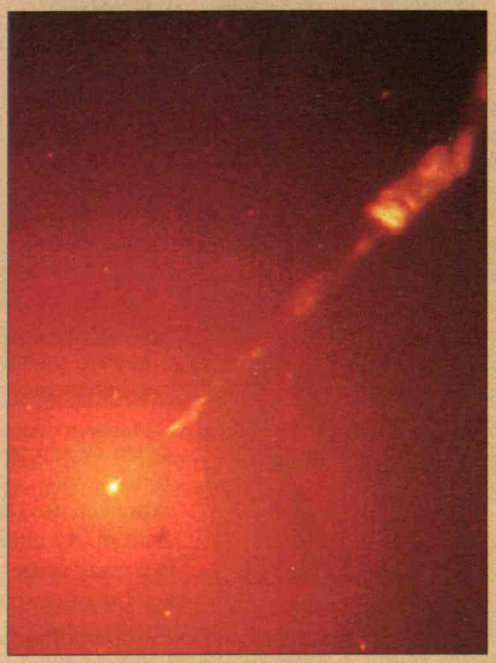
Before its optics were repaired last year, astronomers using Hubble observed that the number of stars seemed to rise toward the galactic core, suggesting that they were being drawn toward a huge black hole. Still, other explanations could account for the phenomenon, such as the possibility that there are simply a large number of stars in the region.

But Hubble's corrected optics allowed Harms and Ford to clearly resolve the spinning disk. They measured the disk's size and calculated its speed by observing how the color of light in the rotating disk changes slightly as light approaches or recedes from a viewer, a phenomenon called the Doppler shift. Determining that the disk's speed rose steadily, to as high as 1 million miles an hour some 50 million light-years from the center, the researchers estimated that the mass of a gravity source required to hold such a massive disk together at such high velocities would have to be 2 to 3 billion times that of the sun. "The evidence is as conclusive as we're ever going to get that this object is a black hole," says Daniel Weedman, director of the astrophysics program for NASA. "I don't know of any alternative explanation."

Harms and Ford also observed a tremendous amount of electromagnetic radiation streaming from the galaxy's core, further confirmation of a black hole. Indeed, astronomers have known for decades that M87 is a weak version of a quasar, a type of galaxy that emits a display of electromagnetic energy brighter than the rest of the stars in the galaxy. A black hole, theory holds, would create just such an effect as material becomes rapidly condensed and thus superheated as it nears the hole.

Astronomer Douglas O. Richstone, a black-hole hunter at the University of Michigan, concurs that the evidence is compelling. "It's the picture astronomers have been drawing on napkins based on theory for 20 years." Still, he wants to see better evidence, namely that the speeds of the gases continue to climb and eventu-





The Hubble telescope recently revealed a huge swirling pancake of interstellar gas—500 light-years in diameter—rapidly accelerating toward the center of galaxy M87 (far left). The telescope also photographed a jet of electromagnetic radiation streaming from the galaxy's core (near left). Astrophysicists say that only the gravitational force of a black hole could hold such a massive, spinning disk together and condense and superheat material enough to create such intense radiation.

PHOTOS: HOLLAND FORD, RICHARD HARMS

ally reach the speed of light as they approach the center of the galaxy.

Harms plans to use Hubble later this year to make measurements to within 25 light-years. He would like to see the black hole itself but says that no telescope now imaginable would have magnifying powers to resolve the tiny dark spot—which he estimates would occupy an area no larger than our own solar system—in the immense galaxy such a vast distance away.

Meanwhile, scientists are considering the implications of the discovery. Roger Blanford, a physicist at the California Institute of Technology, speculates that black holes played a seminal role in galaxy formation. He imagines that the early universe consisted of huge blankets of gas so massive that they eventually coalesced from their own collective gravitational attraction. The eventually resulting implosion would have been so massive that the gases would have formed a black hole rather than simply coalesced into a star. However, the galaxy's stars would have formed from the remaining blanket fragments and those near the black hole would have fallen in and fed it. Without such a large formative event, Blanford contends, smaller black holes, perhaps created in irregularities in space during the big bang, would have taken a longer time than the galaxy has existed to gobble down enough stars to become as massive as the black hole in M87.

Astronomers are off to look for more of the holes, hoping to learn how common they are and how their sizes vary. Harms will look in nearby Andromeda, which may have a hole with a mass of a relatively puny few tens of millions times that of the sun. Astronomers do not see any jets of radiation there, but that may only mean that the black hole has swept in all the stars and gases within its influence. The Milky Way, earth's home galaxy, may also have a black hole at its core, but it is difficult to see the core through the dense stars and gas and dust from our perch on the galaxy's distant spiral arm.

—*David Graham*

Recycled Architecture

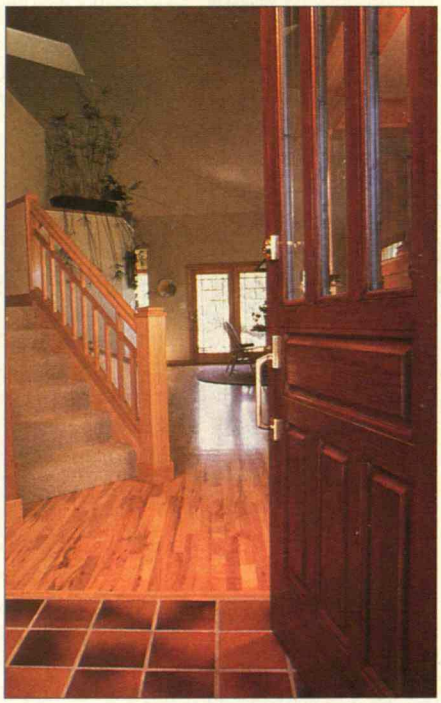
When it is finished later this year, the house that Kate Warner designed at the edge of town in Oak Bluffs, Martha's Vineyard, will look much like the other two-story, single-family homes on the Massachusetts island. But now, before its siding and trim have been added, the house's secret is exposed: it is made almost entirely from recycled materials.

Warner's design represents an incipient revolution in home construction. With the cost of building materials steadily rising, some recycled materials have begun to creep into the building industry. This particular house is one of about a dozen around the country to take the idea to the limit. Built as a model by Warner and an environmentally conscious developer on Martha's Vineyard, the house is intended to demonstrate the potential of recycled building materials. Upon completion, the house will be offered for sale at a competitive price.

Unlike traditional wood-frame houses that use old-growth, large-diameter lumber, Warner's house is framed with so-called composite wood products—lumber engineered from chips of fast-growing, short-lived trees like aspen and poplar, normally discarded because of their slender trunks. The foundation is made with concrete that has been mixed with fly ash—a waste product from incinerators and coal-burning power stations. Because the ash is finer than the sand normally used as an additive and therefore fills voids more completely, the resulting concrete is actually stronger and more impervious to water.

Similarly, the paving bricks used by Warner are made from clay soils contaminated with petroleum products, such as are commonly found around gas stations. The petroleum acts as a lubricant as the clay is forced through a die, and then it burns away or becomes inert during the manufacturing process. Conventional manufacturers, in fact, routinely add petroleum to clay during the extruding process.

The home's insulation is blown cellulose made from recycled newspapers—the main ingredient in the house's wallboards as well. Bathroom tile is manufactured from recycled auto windshields. Even the carpet will be made from recycled plastic bottles.



This model home in Missoula, Mont., was built from recycled materials, including floor tiles made from old car windshields, hardwood floors constructed of salvaged wood, stair rails made from remilled doors, and carpeting composed of recycled wool.

Warner, a Vineyard-based architect, explains that her interest in using recycled building materials stems from the years she spent on the island's solid-waste board. "We ask people to recycle, but then we don't know what to do with the stuff," Warner says. "By making use of waste materials, the manufacturers of these new building materials are creating exciting new markets and completing a loop."

Warner has dubbed the house Recraft East, in deference to a model home built in Missoula, Mont., in 1992 called Recraft 90. That house was the brainchild of Steven Loken, founding director of a Montana-based organization called the Center for Resourceful Building Technology. After spending 24 years in the construction industry, Loken, who served as a consultant on Warner's project, says he was "disgusted by the amount of waste he saw in the construction business" and "disturbed by the effects of clearcutting" of old-growth forests in his home state. He founded the center to pioneer ways of bringing recycled products into the home-building industry.

The need for such new materials is immense. Americans have used more wood fiber than any other single raw material for centuries, and continue to rely upon lumber for the bulk of home building. According to Loken's organization, some 90 percent of all single-family U.S. homes are framed with wood, with new ones averaging 11,000 board-feet of lumber—enough stacked end to end to top the Empire State Building and both World Trade Center towers combined.

While the appetite for construction timber has quadrupled over the past decade, the stock of large-diameter trees has declined. "As timber from old-growth forests becomes rarer and more expensive," Loken explains, builders are resorting to smaller and inferior trees for their stock. But this material often doesn't perform as well. "It has become routine for contractors to throw out as much as 25 percent of the lumber they purchase for a new home," he says.

The scarcity of old-growth lumber is reflected in its steadily rising price: the cost of an average board-foot has doubled over the past two years. Disposal costs have risen as steeply to new highs, providing further impetus for the prudent use of materials.

Despite these pressures, recycled products have been slow to make inroads in the construction industry. Because many of them have yet to find large enough markets, they are still more expensive than their competitors made from vir-

PHOTO: PAUL DIX

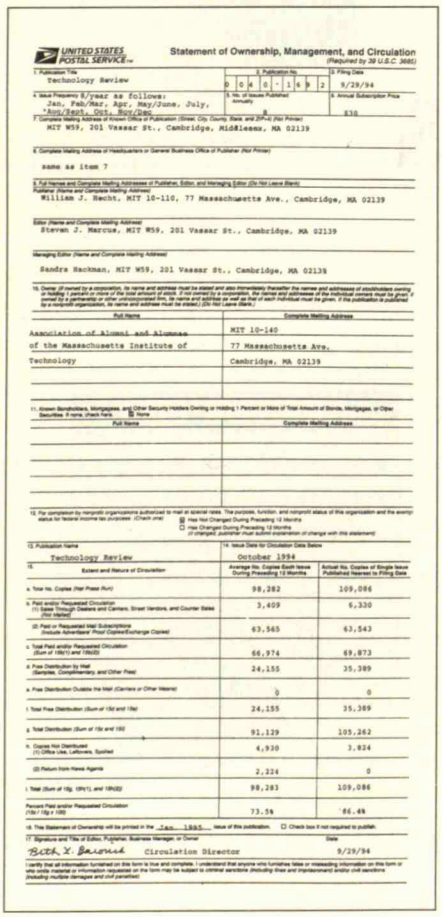
gin materials. And architects and builders need time to learn to master the different properties of the new products. Builders say, for instance, that recycled wallboard is heavier and harder to score and cut than conventional Sheetrock. Unfortunately, Warner points out, "in the field of architecture, there is no continuing education requirement that would force designers to go back and confront these emerging materials and new techniques."

That's why demonstration houses like Recraft 90, Kate Warner's efforts in Martha's Vineyard, and similar projects in Minneapolis, Phoenix, Portland, Ore., and many other locations are so important. "It helps contractors to be able to see the new materials for themselves and talk with other builders who have learned to work with them," says Warner.

Work on another such building is now breaking ground in Seattle, where architect Brian Paul Sweeney is constructing a model conservation house in an old urban neighborhood. Environmental Works, Sweeney's nonprofit design firm, is also compiling a computer database of manufacturers of recycled building products to augment the efforts of Loken's group.

Sweeney believes that designers and contractors will adapt to what he terms "issues of sustainability" just as they have to stringent energy codes and the requirements under the National Disability Act that public buildings and bathrooms be wheelchair-accessible.

Already, the EPA has issued a report that details techniques for building with recycled materials. Beyond that, Loken's group publishes an annual 100-page catalog of building materials made from resource-efficient and recycled materials, and the American Institute of Architects has published an "Energy Resource Guide" that includes analyses of a variety of recycled building products. "Our hope," Sweeney says, "is that these materials and building techniques will become so commonplace that contractors won't see them as extra demands on a project."—*SETH SHULMAN*



UNITED STATES POSTAL SERVICE — Statement of Ownership, Management, and Circulation (Required by 39 U.S.C. 3685)

1. Publication Title	2. Publication No.	3. Filing Date
Technology Review	0 0 4 - 1 6 7 2	9/29/94

4. Issue Frequency: 8/year as follows: Jan, Feb/Mar, Apr, May/June, July, Aug/Sept, Oct, Nov/Dec
5. No. of Issues Published Annually: 8
6. Annual Subscription Price: $30

7. Complete Mailing Address of Known Office of Publication (Street, City, County, State and ZIP+4) (Not Printer): MIT W59, 201 Vassar St., Cambridge, Middlesex, MA 02139

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not Printer): same as item 7

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do Not Leave Blank)
Publisher (Name and Complete Mailing Address): William J. Hecht, MIT 10-110, 77 Massachusetts Ave., Cambridge, MA 02139
Editor (Name and Complete Mailing Address): Steven J. Marcus, MIT W59, 201 Vassar St., Cambridge, MA 02139
Managing Editor (Name and Complete Mailing Address): Sandra Hackman, MIT W59, 201 Vassar St., Cambridge, MA 02139

10. Owner (If owned by a corporation, its name and address must be stated and also immediately thereafter the names and addresses of stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given. If the publication is published by a nonprofit organization, its name and address must be stated.) (Do Not Leave Blank)

Full Name	Complete Mailing Address
Association of Alumni and Alumnae of the Massachusetts Institute of Technology	MIT 10-140 77 Massachusetts Ave. Cambridge, MA 02139

11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check here ☒ None

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12. For completion by nonprofit organizations authorized to mail at special rates. The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes: (Check one) ☒ Has Not Changed During Preceding 12 Months ☐ Has Changed During Preceding 12 Months (If changed, publisher must submit explanation of change with this statement)

13. Publication Name	14. Issue Date for Circulation Data Below
Technology Review	October 1994

15. Extent and Nature of Circulation	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
a. Total No. Copies (Net Press Run)	98,282	109,086
b. Paid and/or Requested Circulation (1) Sales Through Dealers and Carriers, Street Vendors, and Counter Sales (Not Mailed)	3,409	6,330
(2) Paid or Requested Mail Subscriptions (Include Advertisers' Proof Copies/Exchange Copies)	63,565	63,543
c. Total Paid and/or Requested Circulation (Sum of 15b(1) and 15b(2))	66,974	69,873
d. Free Distribution by Mail (Samples, Complimentary, and Other Free)	24,155	35,389
e. Free Distribution Outside the Mail (Carriers or Other Means)	0	0
f. Total Free Distribution (Sum of 15d and 15e)	24,155	35,389
g. Total Distribution (Sum of 15c and 15f)	91,129	105,262
h. Copies Not Distributed (1) Office Use, Leftovers, Spoiled	4,930	3,824
(2) Return from News Agents	2,224	0
i. Total (Sum of 15g, 15h(1), and 15h(2))	98,283	109,086
Percent Paid and/or Requested Circulation (15c / 15g x 100)	73.5%	66.4%

16. This Statement of Ownership will be printed in the Jan. 1995 issue of this publication. ☐ Check box if not required to publish.

17. Signature and Title of Editor, Publisher, Business Manager, or Owner: Beth Y. Balcomb, Circulation Director — Date: 9/29/94

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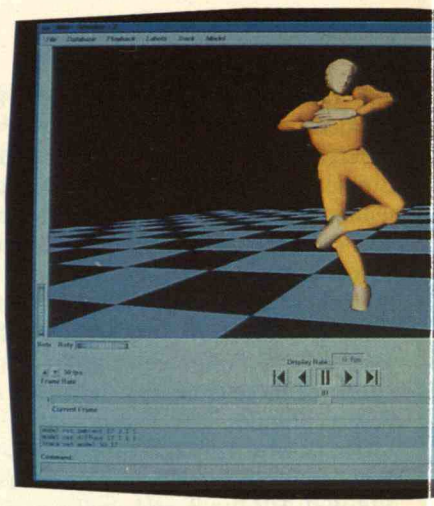
Computers and Dance



When ballerina Jenna Rae Lavin performed a brief duet with the man in the moon in a recent performance of the Atlanta Ballet, her partner was no typical heavenly body. Rather than using a human partner to personify her lunar lover, she danced on stage in front of a 9-by-12-foot screen, on which a computer-generated figure matched her movements step for step

This technological tour de force was part of a new ballet called *Non Sequitur*, which kicked off the company's Dance Technology Project. It marked the first use of a virtual dancer in a performance by a large ballet organization and was made possible by a team of computer scientists led by Michael Sinclair at the Georgia Institute of Technology's Multimedia Technology Research Laboratory. To create the animated partner, the team videotaped a male dancer from the company as he executed 30 seconds' worth of steps for the pas de deux. As he danced, cameras recorded the motion of reflective markers attached to 26 points on his body. Using the spatial coordinates of the markers in each video frame, the computer was able to build a series of images of an electronic double that accurately depicted the dancer's fluid movements.

The computer animation of the man in the moon was sophisticated enough for *Non Sequitur*'s choreographer Lisa deRibere to wish "we had done more" than the half-minute dance between Lavin and her virtual partner. Lavin was similarly impressed. "My first fear was that the computer animation would override the work we're doing," she said after her performance. "But it was great; it didn't detract from the human dancers at all."

Such acceptance of motion-capture and computer-graphics techniques is a recent phenomenon in the dance world, long resistant to technological aids for enhancing art. "The dance form is inherently kinesthetic, something that people express with their bodies," says Tom W. Calvert, a computer scientist at Simon Fraser University in British Columbia, who has developed software for dance choreography. "Dancers are loath to substitute for that."

Audience appeal accounts for some of the recent softening in attitudes. David Asbell, operations manager at the Atlanta Ballet, says that performing arts such as ballet have lost part of their audience to movies and television. Thus he is encouraging the creation of performances that use some of the technological advantages of film and TV. This was one of his company's motivations for inaugurating its Dance Technology Project, which is debuting a series of ballets incorporating advanced technologies.

Other dancers and choreographers are warming to computer technology as they find it can aid them in their conceptual work. The eminent choreographer Merce Cunningham is using a computer-based "sketchbook" called LifeForms, developed by Calvert's team at Simon Fraser, to create new dances. The program allows him to build and display sequences executed by models created from simple mannequin-like figures provided by the software. The bodies of the preprogrammed figures are created using biomechanical models of an average human body to discourage inexperienced choreographers from inadvertently designing dances that ignore human physical limitations and risk injury to dancers. Though the anatomical realism of these figures is not elaborate, movements and stances are shown in enough detail for

PHOTO: STANLEY LEARY

Computer animations created from videotaped footage of dancers can help analyze routines and techniques. For example, the computer can isolate a specific movement and show it from several perspectives.

Cunningham to visualize dance sequences. The software also suggests motions such as transitional movements between positions, some of which he has incorporated into his dances.

In the next few years, the Atlanta Ballet plans to collaborate with Georgia Tech's Sinclair and other researchers in developing computer applications for dance training and performance. Sinclair says that motion capture's usefulness as a training tool was dramatically underlined for him the day he first showed one of his animations to representatives of the Atlanta Ballet. "The head of the dancer we had videotaped was wobbling, and you could see that in the animation," he says. "The ability of the computer to show this small technique flaw clearly startled members of the company."

Motion-capture animations can allow specific movements to be isolated and viewed from several perspectives. For instance, if a dancer wishes to study hand motions during a particular sequence, the other parts of the body can be erased from the screen. In this way, Sinclair says, "you are no longer a slave to the viewpoint of the cameras."

Dancers also need not be limited to analyzing movements that they have actually made, Sinclair says. Software enhancements now under development seek to make it possible to ask "what-if" questions through animation. For example, a dancer might want to know how a pirouette would change given a new arm position. Rather than videotape an actual performance, a dancer could change the orientation of a model's arm in an animated rendering and determine the exact modification that best achieved the goal.

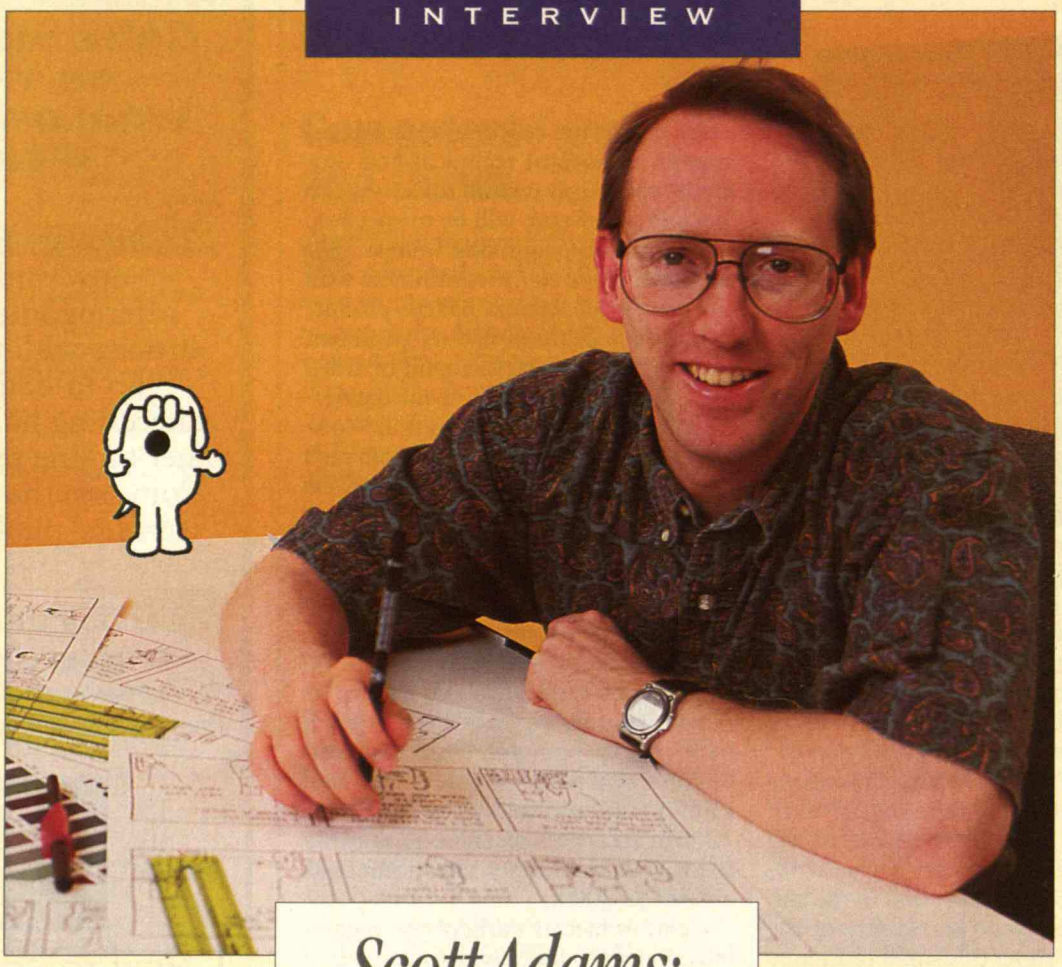
As promising as these innovations appear, important technical and economic challenges remain. According to Sinclair, a key task will be to speed up the process of digitizing images. For example, computer programmers who worked on the Atlanta Ballet's production of *Non Sequitur* had to spend two hours to convert each second of video footage to digital format. In the digitization process, the motion-capture software examined the videotapes from each camera and tracked each of the markers on the dancer's body from frame to frame. Because the markers sometimes disappeared from view or coalesced into one another, programmers had to manually assist the software in keeping track of each marker's position.

One commercial system, known as Flock of Birds, digitizes images much more rapidly, but requires the dancer to be connected to the system by wire and cannot track motion beyond a 12-by-12-foot area. Perhaps more prohibitive to many dance troupes, the system costs around $32,000.

Cost, in fact, is perhaps the biggest impediment to more widespread use of computers in dance. Sinclair says the price for a complete system—with motion-capture, digitizing, and animation software capable of producing sophisticated graphics like those in *Non Sequitur*—now ranges from approximately $50,000 to $350,000. Further, because no such packages are designed specifically for dance applications, he adds, ballet companies that could afford the necessary equipment would also need to hire a computer specialist to adapt and operate it.

As computer technology becomes ever more affordable, Sinclair expects new systems to come within the price range of a typical dance company. In the meantime, a less expensive option is to use a package such as LifeForms that enables dance professionals to conceptualize new routines. The software costs $2,000 for a version that runs on computer graphics workstations and $500 for a package that produces less sophisticated results on a personal computer.—*MARK HODGES*

INTERVIEW



Scott Adams: Gadfly of the High-Tech Workplace

You know that you've made it in the business world when your stippled pen-and-ink likeness appears on the front page of the *Wall Street Journal*. Scott Adams got there recently, but not by virtue of his skill at negotiating corporate mergers. Rather, his specialty is skewering the very people whose faces one is accustomed to seeing in the nation's business pages.

Adams, the 37-year-old creator of the comic strip "Dilbert," dispenses barbs at vicious bosses, out-of-control technology, and pointless bureacracy in the funny pages of over 260 newspapers in the United States and abroad, as well as on the Internet's World Wide Web and America Online. The title character—the rotund, mouthless Dilbert, whose tie has a permanent upward crook like a saxophone—is an electrical engineer and computer

PHOTO: LIANE ENKELLS

programmer in the employ of a corporation that serves no obvious purpose. Dilbert suffers repeated indignities at the hands of his supervisor, whom Adams describes alternately as "Everyboss" and "the exaggeration of the worst boss ever." Boss to Dilbert: "I decided to recognize you for your job performance. So I named one of my pencils after you." In fact, everybody hits on Dilbert. Bumped from an airline flight, Dilbert is last seen strapped to the wing and wondering if there really is a "duct tape section." The only character whose self-esteem remains intact is Dilbert's semifaithful hound, the bespectacled Dogbert, who often gets the last word.

"Dilbert," first syndicated in 1989, offers something for practically everyone who works in a white-collar setting. For executives who can tolerate gibes at attitudes and principles they hold dear, it is an informal, not-for-credit management course that convenes daily. For the masses of underlings who have little control over their corporate destinies, the strip is both a vindication and a survival guide.

But perhaps the main beneficiaries of "Dilbert"—provided they have a sense of irony—are engineers and other technical professionals, whose foibles "Dilbert" exhaustively catalogs. Seated at his computer, a software developer is trying to design a user-friendly product: "I'll make the command easy to remember, like 'CTRL-ALT-F4-DEL.' And if they forget that, they can just edit the source code in 'COMMAND.COM.' Perfect." Martha Gray, an associate professor of electrical and medical engineering at MIT, doesn't mind this kidding a bit. "One of my collaborators, a biologist, clips and sends me the strip whenever it makes a suitable jab at the way engineers think," she says. "I find it amazingly accurate."

Although Dilbert usually ends up the worse for any encounter with his co-workers, engineers can take heart when he parlays his technical skill into social advantage. A typical "revenge of the nerds" scenario:

Office thug: Yo, Dilbert, give me your lunch money or I'll erase your data diskettes.

Dilbert: Touch my data and I'll erase any mention of you from the main payroll computer.

Office thug: No . . . Please, I'm sorry.

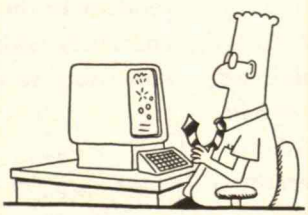
Dilbert (to audience): Nothing is more pathetic than an aging school bully.

Office thug: I took shop; I can make you some nice bookends.

"Dilbert" strikes such a chord with engineering types that Adams and his fictional creation were named to the "All-Star Team" of influential engineers as part of 1994's National Engineers Week, sponsored by several august professional associations.

As the strip's popularity spreads, its shy but acerbic author is becoming a veritable guru of the high-tech workplace. "Dilbert" strips can be found taped to cubicles in engineering firms, law offices, and accounting houses. Adams's speaking engagements at conferences are mobbed. Book signings that accompany the publication of "Dilbert" collections—with titles such as *Build a Better Life by Stealing Office Supplies* and *Always Postpone Meetings with Time-Wast-*

The creator of the popular comic strip "Dilbert" sounds off on what makes office culture sick and engineers tick.



ing Morons—draw hundreds of autograph seekers. And management experts like Tom Peters (the excellence maven) and Michael Hammer (the father of "reengineering") have requested original drawings of strips that lampooned their pet theories.

Adams is well situated to observe engineering and workplace culture. First, there is his day job. While pursuing an MBA from the University of California at Berkeley in the early 1980s, Adams went to work for Crocker National Bank in a position that required him to learn computer programming. For the past nine years, he has worked as an applications engineer at Pacific Bell in San Ramon, Calif., a job that he says provides him with plenty of fodder for "Dilbert." "There's no such thing as an entirely bad day," Adams likes to say, "because the worst day is just material for the strip." He draws "Dilbert" in pencil each morning between 5 and 6 o'clock and inks it in while watching TV in the evening.

But Adams's main window on the working world is provided by his readers. For several years, the cartoonist has published his e-mail address in each strip, enabling fans to bombard him with their office tribulations. Adams has accumulated thousands of corporate horror stories, many of which transform themselves into episodes of "Dilbert." His e-mail address, by the way, is <scottadams@aol.com>.

David Brittan, a senior editor of *Technology Review*, recently ventured into the cul-de-sac-lined foothills of Dublin, Calif., east of San Francisco, where he found Scott Adams nursing a sprained wrist but otherwise feisty and certainly not pulling any punches.

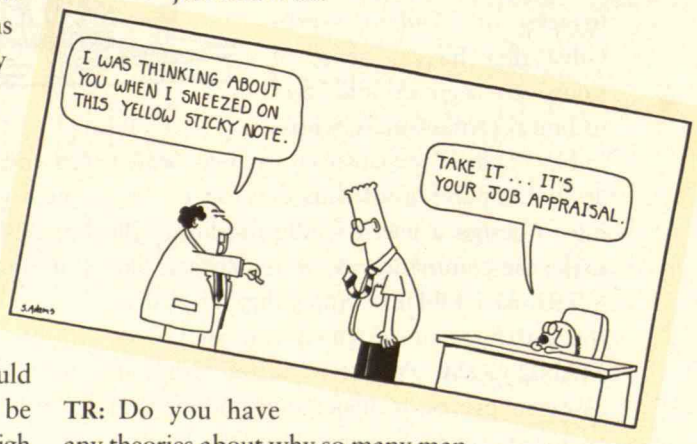
TR: Do the experiences that readers describe in their e-mail messages continue to suprise you?

ADAMS: I got a great one recently. Somebody wrote that people had been riding their bicycles to work and they would bring them inside, not wanting them to be stolen. Then a memo came down from on high that said, "You cannot have bicycles indoors." So this individual wrote back, "I understand how you wouldn't want bicycles in the hallway, but how about in our offices, where we already have lots of personal effects?" The response came back: "It's a fire hazard."

The guy replied, "How could it be a fire hazard in my office with the rest of my furniture?" The response came back that if there was grease sealed inside the bicycle frame and it got heated up, it could catch fire and make the bike blow up like a bomb. The management was actually afraid of exploding bicycles. The guy wrote back, "First of all, I've checked to make sure my grease is not flammable and second that the frame is not sealed. And third, I'm surrounded by other things that say 'flammable,' like the cleaner for the whiteboard." He lost.

TR: Is management usually the villain in these accounts?

ADAMS: I certainly get a lot of horrible-boss stories. Most of them are people telling me that what happened in the strip was identical to something that happened to them. My favorite, which did appear in the strip, was about a company that was giving out these little five-cent fuzzy things if you did a good job—a "warm fuzzy" that you were supposed to stick on your lapel. It just so completely and utterly misses what makes humans feel good about themselves or motivates them. That somebody would think giving this warm fuzzy would do the trick—to me that just said it all.

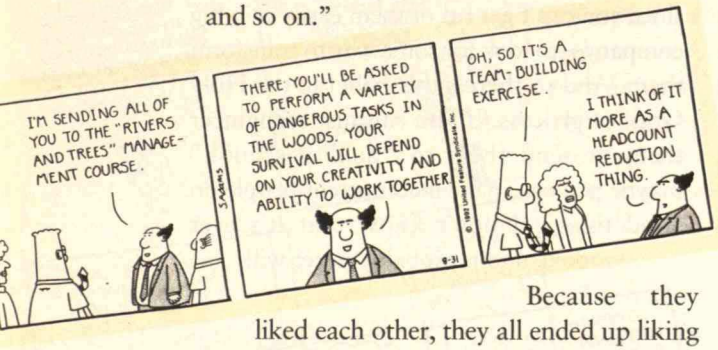


TR: Do you have any theories about why so many managers can't manage?

ADAMS: I suspect that most managers don't

study management. I know that if my own managers ever took a class on how to manage people, it was probably a long time ago.

I think a lot of that stuff is learnable, either in a formal setting or by example. At Pacific Bell, employees were asked to rate their management. We found that the winner was somebody who was a great manager and the runner-up was somebody who worked *for* that person and simply copied his management style. The employees, as it turned out, had no clue as to what these people were doing right. But the second-ranked manager happens to be my girlfriend, so of course I could ask her. Her technique was very simple. She handpicked her group, and she did it by chemistry, which is what her mentor did. She would say, "I've got these people who are good at this, you need someone who's just an energy source, you want both males and females so you've got a good mix of thought, and so on."



Because they liked each other, they all ended up liking their jobs and they didn't mind the long hours. This was really the whole secret, and everything else took care of itself.

TR: That's all it took to get people motivated?

ADAMS: I think that humans are kind of pack animals; if they get any semblance of good leadership, they will rally. So you really have to screw up to be a bad manager. But obviously it happens all the time.

TR: Dilbert's boss is incredibly out of touch with the work that Dilbert and his colleagues are doing. Do you think that's a particular pitfall of managing in a high-tech environment, where so much of the work is highly specialized?

ADAMS: In the old days, if you were a bricklayer who got promoted to CEO of brickmaking, you pretty much knew what a brick was, and if somebody came to you with an idea, you'd know whether it was a good idea or a bad idea. But now if you're deciding whether to put in a wide-area network and whether you're going to use something like "asynchronous transfer mode" technology, it's unlikely you can know anything except what your people are telling you.

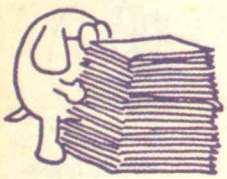
You have this unique situation in history where the boss can't know what the employees are doing and can't really evaluate whether they're doing it correctly. They always have the ability to say "I'm not done yet, but here's a good reason why," and the reason will always sound convincing. So yeah, the boss is at a disadvantage. Really the only thing that works is to make the employees feel that doing the work is better than not doing the work, and doing it right is better than not doing it right—and to try to get the best people.

TR: Do you ever think about how you would do things differently if you were a manager?

ADAMS: I *have* been a manager in past incarnations, and who knows how good I was. The main thing I tried to do was make people feel like they'd rather come to work than stay home, and put a big emphasis on having a good time. Was that good? I don't know, but *I* had a good time.

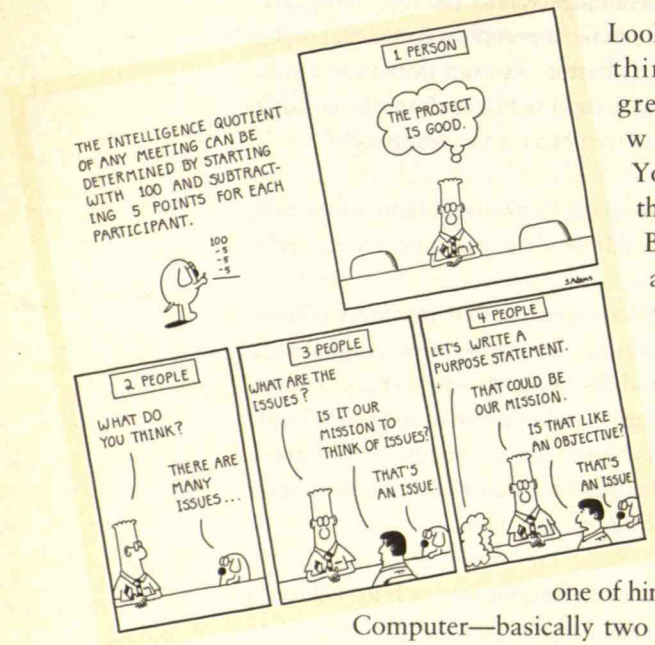
TR: That would be quite a stretch for Dilbert's boss, wouldn't it?

ADAMS: It would be a stretch for most bosses. In an *Industry Week* survey a few years ago, three out of five managers reported that they didn't have fun at work, and of course lots of employers are suspicious of humor in the workplace.



TR: You've said in the past that your strip plumbs those areas where "otherwise normal and intelligent people are idiots." What is it about office culture that reduces people to this state?

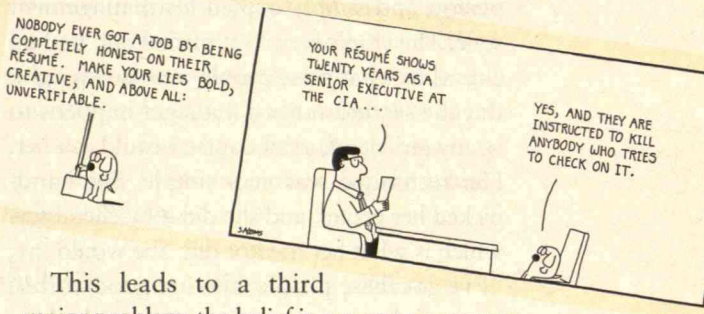
ADAMS: First, there's the well-known phenomenon where you can't do anything useful with more than three people. With three people there's never a tie in making decisions, and the number is small enough so you can get together and schedule meetings. As soon as you reach four people, the IQ of the group goes down to about 90, and the ability to schedule a meeting is out of control—plus the likelihood of a tie goes up, so you rarely get an overwhelming consensus.



Look at anything truly great in the world. You've got the Wright Brothers, and there were two of them. You've got Einstein, and there was one of him. Apple Computer—basically two of them, and later when they decided they needed to invent the Macintosh, they took a very small group of people and broke them off from the company. So the law of numbers is number one.

Studies have shown that the most effective group is where one person is much smarter than the others and everybody else knows it. The worst group is when you've got, say, five really smart people, because they all think they've got a better idea.

Another problem is the difficulty of hiring the right people for the right job. I don't have the answer for that, but I know that if all you're doing is talking to them, looking at their recommendations—which are always going to say "godlike"—and reading their résumé, it's a crapshoot. You often end up with people who are great on paper but can't actually do what you hired them to do.



This leads to a third major problem: the belief in process over capability. Now that you've got six really unqualified people in your group, the tendency is—since you can't get rid of them easily in a big company—to look for some way to transform them. And so there's this belief in the Holy Grail of process. If you can just reengineer them or send them to "quality school," maybe you can make incompetent people do good things. I don't know that it's ever worked, and it probably never will.

TR: What management "process" do you consider the most misguided?

ADAMS: I think empowerment is the silliest concept ever. Of course, you can't control everything your employees do, so you've got to give them some amount of authority. But empowerment assumes that your employees are capable of making the right decisions—and in my experience they're often not.

Empowerment works great in places like Nordstrom department stores, because there's

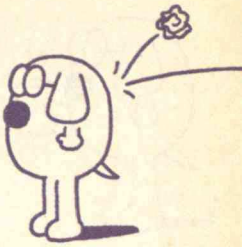
such a well-defined situation. Nordstrom salespeople follow a simple rule in dealing with customers: whatever is wrong, make it right. The worst that could happen is something that supposedly *did* happen: somebody came in to return tires and the salesperson gave them a refund. The trouble is, Nordstrom doesn't sell tires. Even that came out OK because now people hear this story and want to shop at Nordstrom.

In a corporate setting, however, the worst thing an employee could do is blow millions of dollars. The worst case is just so bad that you can't really "empower" the employees except in a teeny, teeny, narrow range of things. Managers will let them order pencils and hope that this will somehow make a difference in the world.

TR: Surely there are successful examples of corporate empowerment that other companies can use as models.

ADAMS: Companies don't know how to use models. They superficially study examples in unrelated businesses and try to apply them to themselves. People manage by anecdote. Executives look at the building of the Macintosh and say, "Yep, that's the model. You take a bunch of people and go off unfettered and develop something." That worked for Apple because the people they took were some of the smartest people who've ever walked the face of the earth—bonafide geniuses. And they had several of them, which may just have been a huge coincidence. Plus they had the company's CEO on their team, so they had unlimited resources.

But other companies—and I've seen this happen half a dozen times—fail to analyze the analogy correctly. They'll decide to follow the Macintosh model and then they'll pick the one thing that's the least important to that model to replicate. They'll say, "Well, it must have been because they were in a separate building." So they'll take all these people who are not performing but maybe have PhDs, and they'll put them in this building—without the CEO, of course, so they'll have no power and no money. And the company will say, "Go build us a Macintosh." It couldn't possibly work.



TR: I'm surprised you're so negative toward empowerment, since Dilbert always seems to be at the mercy of corporate whims. Wouldn't Dilbert be a happier guy if he had a little more autonomy?

ADAMS: I'm positive on empowerment in situations where it can work. But empowerment is a relatively minor issue for Dilbert. The real story of Dilbert is the basic disregard for his dignity as a human being, which is the biggest problem in workplaces generally. If you acknowledge people's basic dignity, suddenly all these other things seem less important. If somebody's feeling good about their job, they're going to go the extra mile.

In my first job out of school, I was a bank teller. We were constantly told, "You have to use your judgment." But then if we cashed a bad check, which happened every day, we'd get yelled at. "You have to follow the rules," they'd say. "If you had followed the rules, you would have seen that he didn't have two IDs and his balance wasn't twice the amount of the check, and that you should not have cashed that

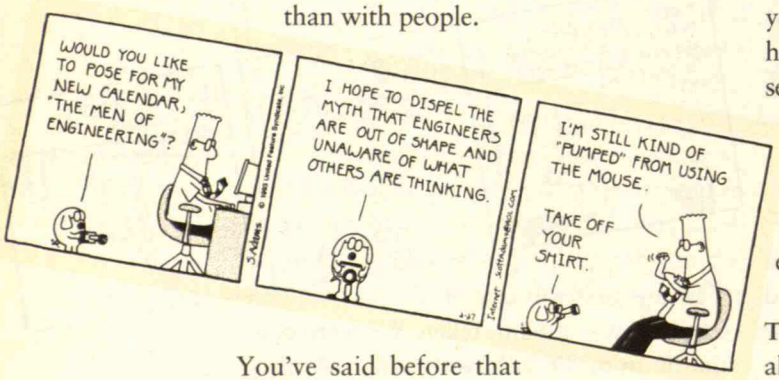
check." But there were so many rules that if you followed them all, you couldn't do your job. So then we'd get into what might be called destructive compliance. We would try to follow the rules for a day, and the line would literally go out the door and wrap around the building, and the complaints would start. Suddenly the management would back off again and say, "You have to use your judgment."

The point is that if I had felt good about that job and hadn't feared that my supervisor would call me stupid when I made a mistake, I would have tried harder to do the right thing and would have been much more efficient. I don't know if that's empowerment, but it's feeling that doing the right thing will create the right result.

TR: Is there anything Dilbert could do to avoid having his dignity stomped on?

ADAMS: Nah, he's kind of caught in the system. His entire self-worth is wrapped up in the fact that he has incredible facility with technology. Whether he uses it for anything beneficial is another story, but he's real good at it, and therefore he spends time, as we all do, doing those things he does best.

TR: Dilbert is the stereotypical nerdy engineer—he's socially inept, slightly misanthropic, more comfortable with machines than with people.



You've said before that this is because he's extremely focused on his work and in love with technology. Yet plenty of professionals in other fields are equally obsessed with their work without coming off as nerds.

ADAMS: There is a difference. Having done a lot of programming for a number of years, I can say that you actually lose the ability to communicate with people after you've done it for a while.

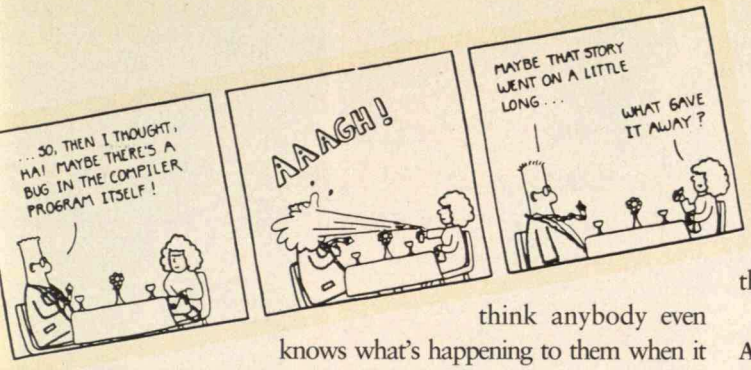
The best way I can explain it is this: Imagine that you're sitting at your computer and trying to write thousands of lines of instructions that will make something happen on your computer. At first, you just memorize a bunch of commands: if you do *x*, then *y* happens. But after you get good at it, you lose all sense that you're sitting there typing. The computer language no longer looks like bizarre code; you start thinking in it the way you think in English.

The next thing you find is that in order to imagine how these thousands of lines of code are all related to each other and how they branch, you start imagining the program with you physically inside it, like a pinball machine. You say, "All right, if the control of the program is that ball that's coming down, and if I don't want it to go right through the middle, I'm going to build a bumper." That's one line of code. And you say, "But wait, the bumper is too small. I need a bigger bumper, and I need the ball to bounce off it in a certain way at a certain velocity." That's three more lines of code. "But wait, if I'm adding *these* three lines of code, then I've also got to have a bumper over here."

So what you find is that you actually take yourself out of your body, and you spend hours doing something as exciting as sex. This seems unimaginable unless you've experienced it, but once you've been inside the pinball machine for a while, and you finally hit the flipper and the ball comes down right where you wanted it to, it is an exhilarating experience. It's unlike anything else.

TR: Have you heard other programmers talk about this in the same terms?

ADAMS: Some people refer to the "daze" or "being lost in cyberspace." Or else you see the glassy look in people's eyes, and when they talk, they talk as if you would understand their pinball machine, which you couldn't possibly. So you see the symptoms of it, although I don't



think anybody even knows what's happening to them when it happens. I know that when I'm programming, my girlfriend usually comments that I become uncommunicative for long periods of time.

TR: Of course, programming is a narrow subset of engineering, and a relatively recent one.

ADAMS: It doesn't matter if you're a programmer or a chemical engineer or a bridge builder—all types of design offer the same transcendental experience. You're inside the molecules and you're manipulating them, or you're mentally floating around the bridge. The thrill is intense, and I don't think you can experience it unless you have the kind of mind that can spend long periods inside the pinball machine. Not everybody can do that. Some people, for example, need to read a novel and have somebody else's imagination impressed upon them. Other people say, "Nothing I could read in a novel would be as interesting as what I can think and imagine and create on my own." So there are two kinds of people: those who want imagination given to them and those who want to be part of constructing it. The latter become engineers.

TR: Do the strip's biggest supporters resemble Dilbert in some way?

ADAMS: The most dedicated "Dilbert" readers could probably be characterized as nerds, but fans actually run the gamut. I spoke in Canada at a society of geological engineers, and the room was full of people in suits who all looked like they just came out of a business meeting. There probably wasn't an identifiable nerd within the group of 700—nah, I take that back. It was probably 5 percent hard-core nerd content; the rest were just businesspeople.

TR: I thought you would have alienated that 95 percent.

ADAMS: It surprises the hell out of me, but some of the biggest "Dilbert" fans are lawyers—an amazing number of them have asked for originals—and I nail lawyers all the time. My portrayal of engineers is certainly not positive either. And marketing people? Tons of fans are marketing people, and you know what I do to them. It's the weirdest job, where you can mock people and they'll like you for it.

TR: Why do you suppose that is?

ADAMS: I think people in a lot of professions often want to scream to the world, "I don't know what I'm doing! I'm just making this up!" So the strip gives them plenty to identify with in that regard. But it's hard for me to figure out why people like what they like, any more than I know why I like my favorite color.

TR: If you were still drawing "Dilbert" strips 20 years from now, would you feel good about it or would you feel you were in a rut?

ADAMS: Totally unpredictable. I guess the job would remain interesting if the nature of the work changed. If we had Dilbertland and Dilbert videos and Dilbert 3D holographic nanoworlds, that would be very cool. I have no sense of purity that Dilbert will be used in only one way. He's my employee, and damn it, he'll do what I tell him to do.■

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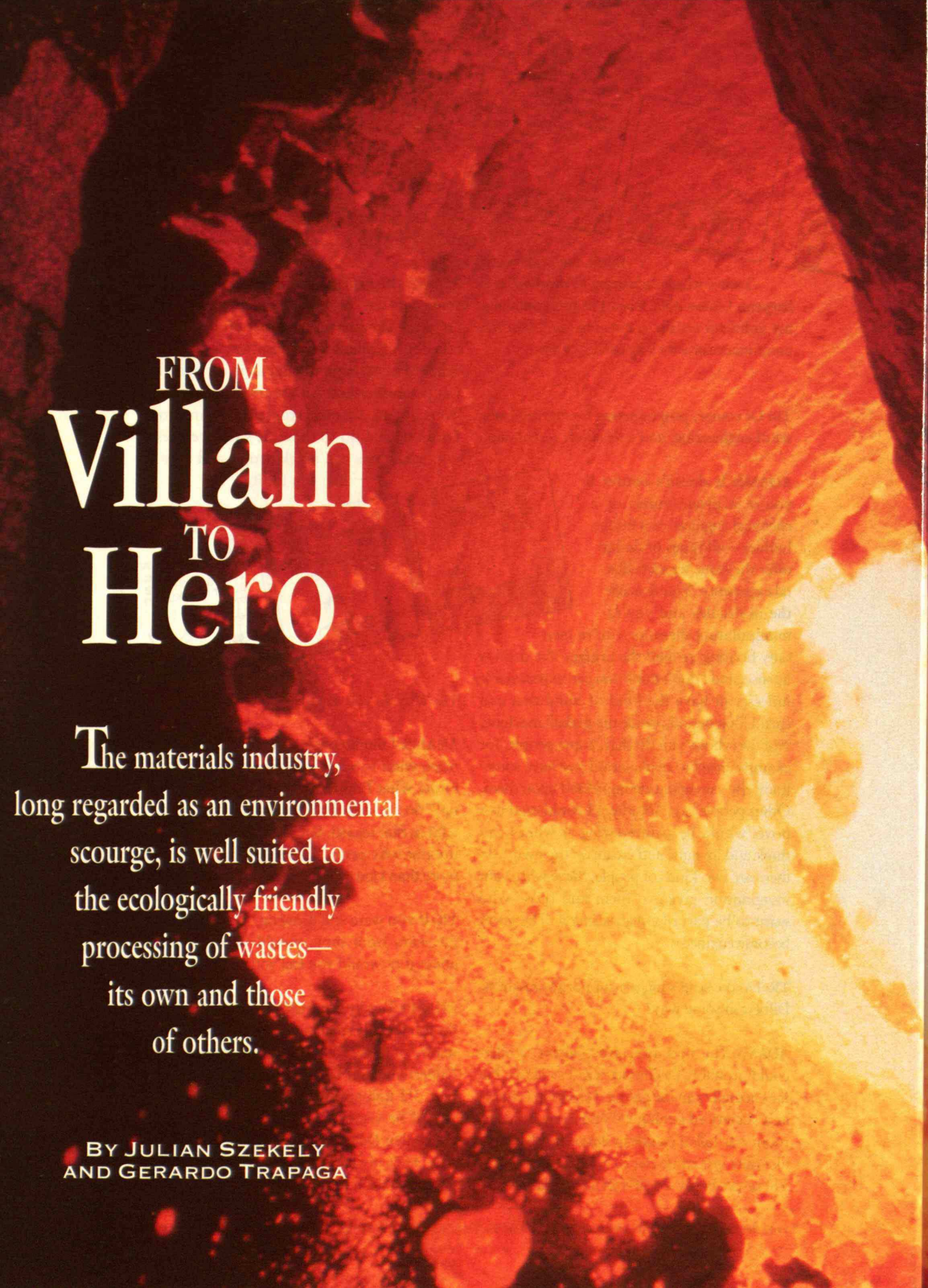

FROM Villain TO Hero

The materials industry, long regarded as an environmental scourge, is well suited to the ecologically friendly processing of wastes—its own and those of others.

BY JULIAN SZEKELY AND GERARDO TRAPAGA

Cement kilns like this one can double as waste disposal systems—either by burning waste as fuel or by incorporating waste into the cement itself.

THE fumes, dust, and polluted waters in the 1950s and 1960s of such rustbelt cities as Pittsburgh, Gary, and Youngstown are firmly etched in many people's minds. For decades, producers of tonnage materials—steel in particular—single-mindedly emphasized the need to boost output and improve product quality. Energy was plentiful and inexpensive, so conservation was of secondary importance, at best.

In the intervening years, environmental concern moved into the political, technological, and economic mainstream. Many of the most polluting plants have been closed; others have been substantially modernized, greatly diminishing the emissions of gaseous, solid, and waterborne effluents. Meanwhile, the oil price shocks of the 1970s forced a drastic rethinking of energy efficiency. The materials industry made great strides through better insulation, improved waste-heat recovery, improved yields, and better process control.

The industry has also seen a substantial decline in its energy use owing to an upsurge in recycling. The energy needed to produce a metal from recycled scrap is usually a tiny fraction of that needed to obtain the metal from virgin ores. As a result, construction of primary processing plants in developed countries has ground to a virtual halt during the past two decades. This has been most apparent in the steel industry, where the so-called minimills, which use scrap as their raw material, have come to prominence (*see "A Rosy Future in Scrap," page 34*).

Closer attention to the environment traces back to the imposition in the early 1970s of progressively stricter emissions regulations. Although at first the materials industry bitterly fought many of these environmental initiatives, over time companies significantly adjusted their processes to substantially reduce their pollutant emissions into the air and water.

These changes have not been without cost. Most efforts at environmental compliance have focused on "end-of-the-pipe" treatment, such as the fitting of electrostatic precipitators for gaseous emissions and even entire wastewater treatment facilities; these measures have typically added 20 to 30 percent to the cost of a new plant. But less tangible benefits of greater environmental concern have become apparent. Environmental cleanliness enhances a company's public image; cleaner plants make better neighbors. Employee morale can improve, too; it is much easier to insist on high standards of product quality in clean plants. For example, Norsk Hydro, a Norwegian producer of aluminum and magnesium, recently reported that steps the company took to reduce fluoride emissions from its smelter plant improved worker productivity. The bottom line is that environmental consciousness has been good for business. Compared with their counterparts of a couple of decades ago, today's plants produce materials of higher quality at a substantially lower real cost.

In a 100-foot-tall chamber, Magnetics International recovers iron oxide powder and hydrochloric acid from the liquid known as "pickle liquor" left over from treating steel sheets. The magnetic powder can be used in electric motors and loudspeakers.

Finding Uses for "Wastes"

And yet the materials industry has in a sense been a victim of its own success. The volume of materials consumed per capita in the United States has changed just a little over the years. Implicit in this trend is that the *weight* of materials consumed has actually decreased, as we are replacing heavier grades of steel with thinner-gauge, higher-performance steels; steel with aluminum; and aluminum with plastics or composites. By producing steels of higher quality, for example, we need less to perform the same duty: a full-sized passenger car sedan built in 1994 requires 18 percent less steel than a comparably sized vehicle built in 1964.

Because of economic pressures from other producers and the development of competing materials, steelmakers have been unable to raise their prices to reflect this improved performance. The price for a ton of steel has remained at about 20 cents per pound for the last two decades, notwithstanding the three-fold increase in the consumer price index during those years. The situation for copper, lead, and aluminum is similar; indeed, aluminum actually costs less today than it did 20 years ago.

The economic future of the large-scale materials industry may therefore lie with an ancillary, and expandable, activity—waste recovery—that could also help complete its image change in the environmental drama from villain to hero. Primary materials processors—that is, operations that make refined products such as steel from raw ore dug from the earth—have unique expertise in handling large tonnages of materials at high temperatures and under closely controlled conditions. This is the same kind of know-how that is needed for the treatment and disposal of wastes.

The primary materials industry has already laid down a bedrock of basic science, spending decades answering

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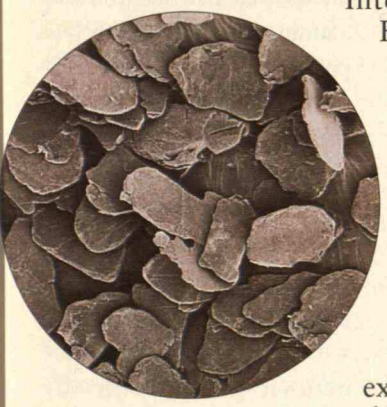
PHOTO, PREVIOUS PAGE: TEXAS INDUSTRIES; ABOVE: MAGNETICS INTERNATIONAL INC.

such question as: What is the equilibrium composition of a mixture? How rapidly does it generate or absorb heat? How are the materials best contacted, mixed, and ultimately separated? This hard-won base of knowledge is an important scientific and technological resource that can now be exploited in the disposal of many solid wastes. And because materials industries have built up significant excess capacity, it makes economic sense to develop a strategy of using its idle facilities for resource recovery and waste recycling.

Such applications can make excellent commercial sense.

■ *PICKLE LIQUOR:* After steel is rolled into sheets, the surface must be cleansed of oxides and other impurities. Steelmakers do this by immersing the sheet in a highly acidic solution called a pickling bath. Disposal of the "pickle liquor" that is left over from this process is difficult. Not only is the liquid still highly acidic, but it contains dissolved ferric chloride and other heavy metals. In the past, steelmakers have often simply stored, or "lagooned" these solutions. Another alternative has been to inject the waste into deep wells. Neither method is environmentally sound, because each risks introducing heavy metals into the drinking water of neighboring communities. Indeed, lagooning is now discouraged or even prohibited.



A new method for processing "kish"—the mixture of iron oxides and graphite that steel mills produce when pouring molten iron from ladle to ladle—yields graphite flakes that can be used in a variety of self-lubricating products.

Researchers at Magnetics International in Burns Harbor, Ind., a subsidiary of Inland Steel, have developed an elegant and commercially viable technology to treat and recover pickle liquor. The liquid is sprayed at high pressure into a 100-foot-tall "roasting" chamber, in which the temperature exceeds 1,200F. The iron chloride reacts with the oxygen in the hot chamber to yield a pure form of iron oxide. Inland turns the iron oxide into 25,000 tons of magnetic powder per year; such powders can be used in a variety of products including electric motors, loudspeakers, and refrigerator gaskets. The process also produces hydrochloric acid, another product with commercial value.

■ *GOODBYE, KISH:* Pouring molten iron from ladle to ladle results in the evolution of a fine black-gray powder called "kish." This mixture of graphite and iron oxides has traditionally been regarded as a useless waste, but Inland Steel now recovers high-quality graphite from this residue. The kish, collected from air filters installed throughout the plant, undergoes a series of leaching steps in acidic solutions. The process yields graphite flakes—the starting material for the manufacture of a range of self-lubricating products, such as bushings. Because the manufacture of pure graphite from virgin raw materials can be expensive, this recycling process holds considerable commercial promise. Inland estimates that recycling kish at all its plants could yield about 1,500 tons per year of graphite flakes—about 6 percent of the total U.S. market.

The electric arc furnaces that melt scrap metal in steel minimills (top) produce a dust (middle) that contains heavy metal, rendering it a hazardous waste. Instead of dumping this dust, steelmakers can melt it with glass-forming chemicals to produce an inert material used in ceramic tiles (bottom).

■ *GLASSIFYING DUST:* The fastest growing segment of the steel industry are the so-called minimills, which use electric furnaces to melt scrap metal that is then processed into steel. The dust from these furnaces contains zinc, lead, and cadmium oxides, rendering it a hazardous waste. A promising solution to this problem comes from another materials industry: glass-making. In a process developed by Oregon Steel in Portland, Ore., the dust is melted together with glass-forming chemicals in an electric furnace. The inert, glassy material that results can be used to make a variety of ceramic products such as tiles. (Indeed, because glass is an inert substance, not normally subject to leaching by groundwater, it has long been advocated for encapsulating and safely disposing of radioactive wastes.)

■ *GETTING THE LEAD OUT:* A lead plant operated by Doe Run Corp. in Boss, Mo., uses virtually all the components of recycled lead-acid car batteries. Not only is the lead recovered, but the sulfuric acid is turned into high-grade anhydrous sodium sulfate, which can be sold to makers of glass and laundry detergent.

PHOTOS: INLAND STEEL; PETER SIBBALD; OREGON STEEL MILLS

A Rosy Future in Scrap

Because they produce steel from scrap, minimills are cheaper to build and operate than the plants that use iron ore and coal as raw materials. An aluminum minimill industry could similarly avoid the need to use vast amounts of electricity to refine bauxite.

UNTIL the last decade, most steel was produced directly from materials dug out of the earth. These so-called integrated plants consist of several facilities. Sinter plants agglomerate the ore. Airless ovens heat coal to drive out the volatile compounds, leaving behind coke. The coke and sintered ore are fed into the large vertical shaft of a blast furnace to produce molten pig iron, which is then converted into steel by reacting it with pure oxygen. The molten steel is cast into slabs or billets and then rolled in several stages to obtain the finished shape—thin sheets, plates, bars, beams, or wire.

Integrated steel production generates a lot of waste. Ironmaking and steel-making facilities leave behind slag; sludge is collected from gas-cleaning systems; rolling mills shed waste-water; the acid treatment of steel sheets produces potent "liquors." Coke ovens emit aromatic hydrocarbons, which are known carcinogens. Because of these concerns, no new integrated steel plants have been built in developed countries for over a decade.

The second, growing segment of the industry is represented by the so-called minimills, which use scrap as the raw material. The scrap is melted in electric arc furnaces (no coke is burned), and then processed by continuous casting and rolling. The cost of building a minimill is typically $200–300 per ton of annual production capacity, in contrast to the $1,200–1,500 per annual ton for integrated plants. Furthermore, minimills need only a fraction as much energy and labor—roughly 7 million BTUs and 1–2 person-hours to make a ton of steel, as opposed to 21–24 million BTUs per ton and 3–4 person-hours of labor at an integrated steel plant.

Initially, minimills were limited to making low grades of steel, such as reinforcing bars. But with the introduction of new processing technologies, minimills are making inroads into the broader market. One such technology is thin-slab casting. In conventional steel processing, the molten steel is cast into 10-inch-thick slabs that are then reduced by hot and cold rolling to sheets of the desired final thickness. By casting "thin slabs" that are only 2 inches thick, much of the rolling effort becomes unnecessary, reaping significant savings in capital cost, energy, and labor. The availability of this technology has allowed the minimills to break into a potentially lucrative market.

A minimill industry may also emerge in the aluminum field. Right now, almost all of the 3.7 million tons of aluminum made annually in the United States is produced by the electrolytic decomposition of alumina, a substance found in naturally occurring bauxite ore. Primary aluminum production has important environmental problems, not the least of which is its demand for huge quantities of electricity—some 6 kilowatt-hours per pound. This hunger for power has led to a concentration of aluminum production in areas with cheap electricity, such as Canada, Australia, and Venezuela. By the same token, Japan, with its high power costs, has abandoned primary aluminum production altogether.

In addition, the extraction of alumina from bauxite ore leaves vast lakes of "red mud"—a sludge containing iron oxides, sodium hydroxide, and other undissolved minerals, as well as alumina itself. The electrolysis process produces fluoride emissions. The graphite walls of the electrolysis cells—permeated by sodium fluoride, cyanides, and other contaminants—are difficult to dispose of safely. Secondary aluminum processing, by contrast, involves the melting of aluminum scrap—an energy-efficient operation with minimal impact on the environment.

Today, the companies that recycle aluminum are the same as those that make aluminum from ore. If an independent secondary aluminum industry were to emerge, analogous to the steel minimills, such operations would become the low-cost and therefore dominant producers.■—*JULIAN SZEKELY AND GERARDO TRAPAGA*

PHOTO: PETER SIBBALD

Send Us Your Byproducts

Rather than blotting the landscape, tons of used tires can be burned to fire cement kilns.

Such examples show how materials companies are cleaning up, and finding markets for, their own wastes. But some of the most exciting developments stem from the ability of one type of materials plant to consume waste streams produced by other industrial processes. The cement industry may be prototypical of the kind of industrial synergy that can lead to cost-effective solutions to waste and environmental problems.

Producing cement entails mixing limestone and silica in a ratio of about three-to-one in a long, rotating kiln. This blend is gradually heated to a temperature of about 1,500C by burning coal, oil, or other fuels. Cement kilns are large, robust systems, typically 100 to 150 meters long and 3 to 5 meters in diameter, capable of processing large volumes of materials.

The cement industry can use waste material in three ways. One is by substituting a byproduct from another industrial operation for one or more of the original inputs in the feed stream in a way that leaves the composition and performance of the cement product unimpaired, and possibly even improved. One example is the spent sand from a metal foundry. Even better is blast-furnace slag—which not only supplies the iron that cement requires but also contains lime and silica in the ideal three-to-one ratio. Another required ingredient for cement is calcium sulfate, or gypsum. Gypsum can be mined directly. But calcium sulfate is also a byproduct of the "scrubbing" operation used to clean the stack-gas emissions from power plants and other industrial facilities—including cement plants.

Another way to use waste is to fuel the cement kiln with combustible byproducts of some other industrial operation. In the United States, with the demand for cement stagnant and with environmental regulations getting tighter, many cement companies now have an incentive to replace a substantial portion of their fuel requirements with waste materials. These can include waste oils, organic sludges, and spent solvents such as carbon tetrachloride, trichloroethane, and toluene left over from the manufacture of paint and many other chemicals. Not only will cement companies often get such waste fuel at no cost but they may actually receive payment for disposing of these potentially toxic materials. Indeed, many marginal cement plants depend for their survival on their ability to lower fuel costs and enhance revenue.

The third way the cement industry can become environmentally friendly involves the disposal of waste streams that contribute neither to the composition of the final product nor to the production of heat. These materials are simply incorporated into cement without impairing the quality of the product. Examples include lubricating oil waste and sludge from steelmaking plants. The extreme high temperatures inside the kiln might also be used to destroy certain toxic wastes, breaking them into benign elements and compounds that would be harmlessly encapsulated in the cement. Since cement is produced in huge quantities—90 million tons a year in the United States alone—even the incorporation of 10 to 20 percent of additional byproduct streams represents a substantial amount.

The potential use of cement kilns to recycle and dispose of other materials has long been known. These avenues were not extensively pursued in the United States, however, because energy was plentiful and cheap and because solid wastes could be readily disposed of. This was not the case in Japan or Western Europe, where energy has been more expensive and space for landfills has been severely restricted. Therefore, just as the Japanese and Europeans developed fuel-efficient cars well before the energy crises hit the United States in the 1970s, so too have these countries extensively implemented energy-saving and waste-recycling measures in their cement industries. Japan has been a leader in incorporating various solid wastes—including steelmaking slag and coal-plant tailings—into the feed streams for cement kilns. The Japanese government has also encouraged the use of waste tires as a fuel for cement kilns; in 1992, Mitsubish Materials burned more than 23,000 tons of tires at its cement plants.

The use of cement kilns for the disposal of waste materials is meeting opposition from the incineration industry, which will suffer a substantial loss of business if these technologies gain more widespread adoption. It claims that the kilns are not well enough controlled to dispose of contaminants safely. When the material to be burned is classified as a hazardous waste, for example, the cement maker must keep careful records of the material streams handled and also of the stack emissions to make sure that all the hazardous materials have indeed been destroyed. Such monitoring is a new departure for the cement industry, requiring sophisticated equipment that is absent at many kilns now being used for waste disposal. But there is no fundamental reason why these criteria should not be met in the future. A recent Supreme Court decision favors the cement industry; the Court declared that incinerators are no longer exempt from hazardous-waste regulation.

The cement industry serves as a model for using tonnage materials facilities to recover or dispose of waste

PHOTO: RENEE PURSE/PHOTO RESEARCHERS

streams produced by others. Production of aluminum, for example, results in quantities of leftover solids, known as dross, consisting of an intimate mixture of metallic aluminum and aluminum oxide. The aluminum industry is under a lot of pressure to reduce the amount of dross that it dumps in landfills. One interesting use for this dross is to add it to molten steelmaking slags to help recover iron. Such slag might also be useful starting material for the manufacture of ceramics. And of course the organic wastes burned in some cement kilns could also be burned in any number of materials processing operations, including blast furnaces, and could perhaps even be used to generate additional electricity for power-hungry aluminum plants.

As demand for tonnage materials declines, the industry can apply its process know-how to the businesses of resource recovery and waste recycling.

Ideally, from an environmental standpoint, individual manufacturing operations will exploit each other in synergistic fashion. For example, manufacturers of paper, cement, steel, and glass could collaborate with energy generation plants and with disposers of urban solid waste, with the waste or by-product stream of one plant fully used by another. Texas Industries, a cement manufacturer in Midlothian, Tex., and Chaparral Steel, an electric furnace steelmaker that occupies an adjoining site, are now pursuing such an initiative. The companies have combined several technologies in the pursuit of a zero-waste operation—one that will effectively use every part of a junked automobile. The steel company will melt and reuse the ferrous scrap in electric furnaces; nonferrous metals such as copper and aluminum will be recovered and sold. Combustible wastes, including the tires, can be burned in Texas Industries' kiln. Some of the steel plant wastes—such as the iron oxides, oil, and water that are left over from the rolling mill—will be incorporated into the cement itself. Ideas such as these may allow us to effectively utilize spare facilities, workers, and knowledge. This is the ultimate waste minimization. ■

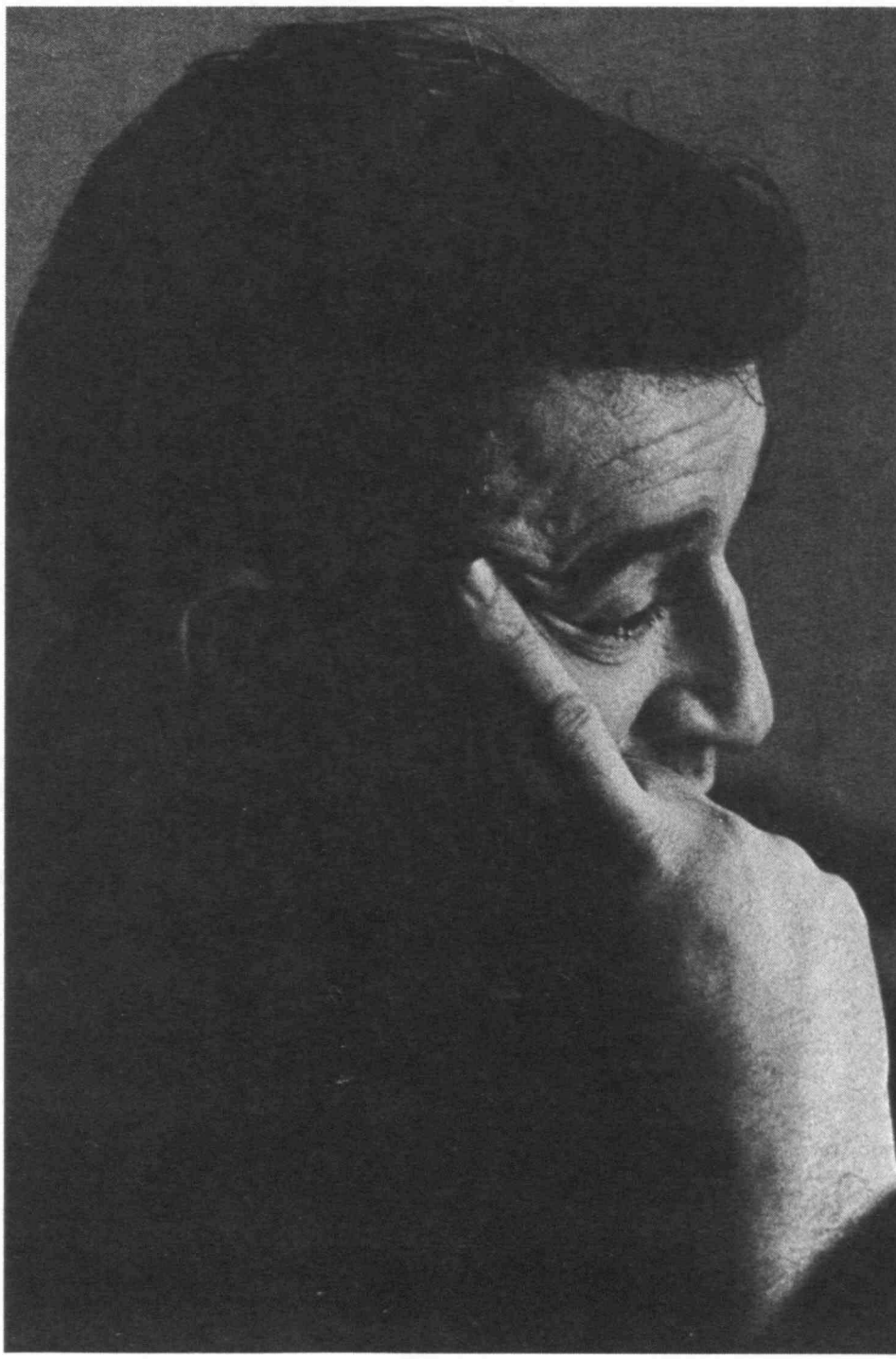
MITnews

FROM THE ASSOCIATION OF ALUMNI AND ALUMNAE OF MIT JANUARY 1995

1915–1994

JEROME WIESNER

A Renaissance Engineer



Jerome Bert Wiesner—electrical engineering educator and researcher, MIT's president from 1971 to 1980, and science advisor to presidents Kennedy and Johnson—was the epitome of the complete man, one who, in the words of poet Matthew Arnold, "saw life steadily and saw it whole."

Wiesner died on October 21 of heart failure at his home in Watertown, Mass. He was 79 years old.

Concerned with the quality of life and the human condition, Wiesner was an abiding champion of peace and justice and an advocate for learning. At his inauguration as MIT's 13th president, he said that the central purpose of any university, "ours in particular, is the quest for learning, the nurture of learning, the transmission of learning, the use of learning. No doctrine, no orthodoxy, no conventional discipline or gust of political passion, can be allowed to divert us from this purpose."

His focus never wavered. For him, life was an uninterrupted learning experience. When faced with setback or defeat, his response was always, "What can we learn from this?"

By Robert Byers

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JANUARY 1995

A Sow's Ear From a Silk Purse *Working on an obituary for Jerry Wiesner was the reverse of the cliché: we already had the silk purse, namely the life of a great man, beloved by this institution. What we had to do was boil it down to something painfully abbreviated—the sow's ear. Among the pieces that ended up on the cutting-room floor (we just couldn't make it fit) was a treasured memory from Jean-Joseph Coté, '83, about an unforgettable occasion in 1983 when Jerry shared his intimate knowledge of the disarmament process with the residents of Senior House. I just want to say how much I envy you and your peers, Jean-Joseph; I never heard Jerry speak, let alone worked with him. Having edited this obituary, I have a glimmer of an idea of what I missed.*—SUSAN LEWIS

Jerome Wiesner

continued

JERRY WIESNER exemplified greatness and spent his career in distinguished company (clockwise from top left): at a high-level meeting in the Johnson White House (Wiesner at left); at the taping of an educational TV broadcast with Eleanor Roosevelt and his daughter Elizabeth; testifying on the need for arms control before the Senate Foreign Relations Committee in 1966; and, as President Kennedy's science advisor, participating in the ceremony at which the 1963 National Science Award was presented to Theodore von Karman.

He coupled his fierce commitment to learning with an equally fierce commitment to the young. At his inaugural, Poet Laureate of the U.S. Archibald MacLeish saluted his friend of three decades with a poem composed for the occasion. There he said:

Advisor to Presidents, the papers call him.
Advisor, I say, to the young.
It's the young who need competent friends, bold companions,
honest men who won't run out,
won't write off mankind, sell up the country,
quit the venture, jibe the ship."

Generations of MIT students were the benefactors of his competence, boldness, and loyalty.

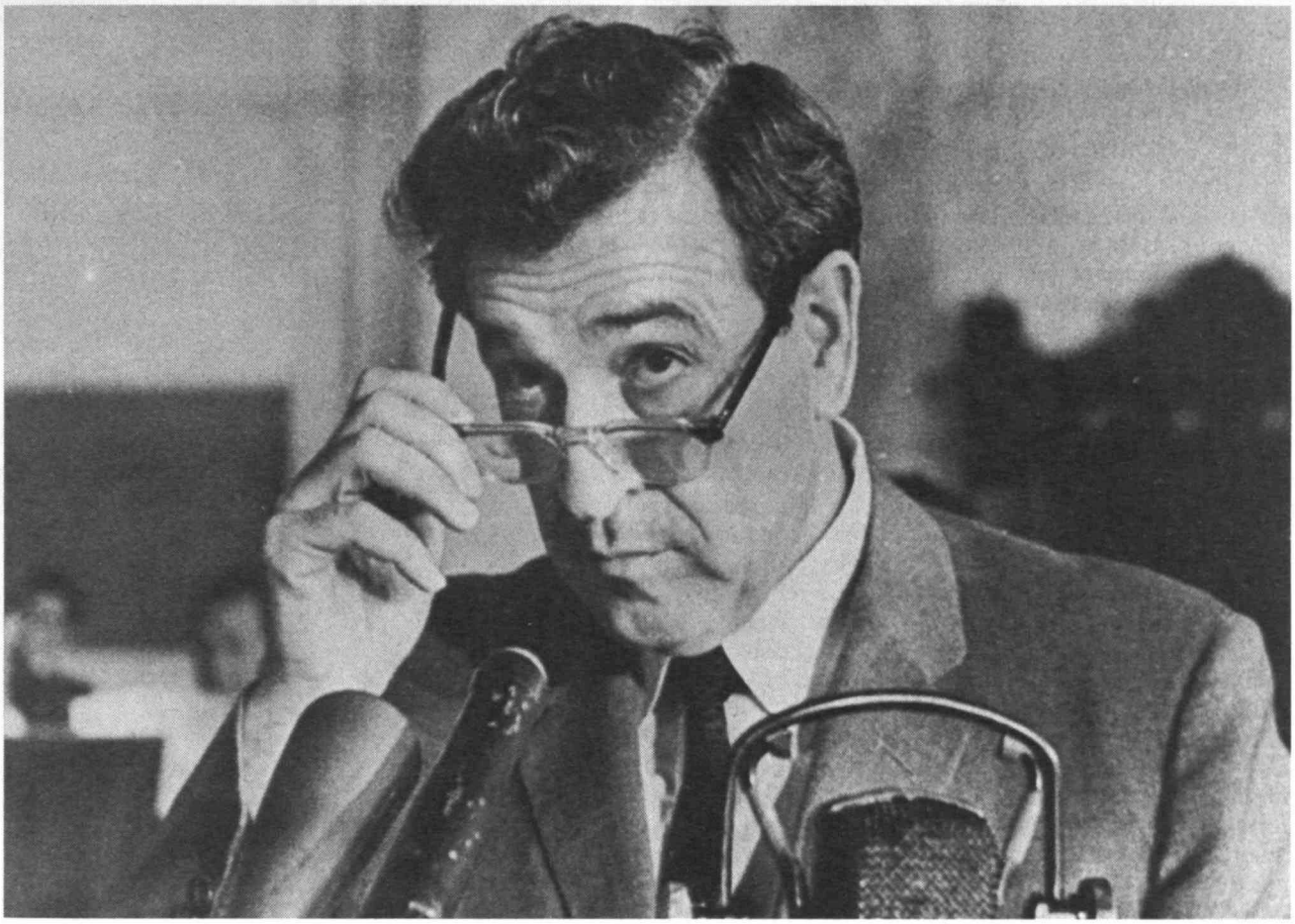
In his 50 years with the Institute, Wiesner made an enormous impact. In his tribute, President Charles Vest stated that Wiesner "did much to build and define MIT as an institution that extends and transcends its core of science and engineering through creative engagement with the humanities, the arts, and the social sciences."

Paul Gray, '54, chair of the Corporation—who served as chancellor during Wiesner's tenure as president and succeeded him in that office—said of his mentor, "This special place has benefited beyond acknowledgment from his fierce belief in the value of racial, ethnic, and gender diversity in this community, from his insistence on intellectual quality in our programs."

Jerry Wiesner was a Renaissance engineer, a member of a summer community of intellectuals, artists, writers, actors, and musicians on Martha's Vineyard that included playwright Lillian Hellman, novelist John Hersey, and conductor Leonard Bernstein. Not only was his own thought influenced by their company, but he persuaded many of these friends to teach and spend time among MIT students.

One of his pivotal experiences as a young faculty member was serving on the Lewis Commission, a study of undergraduate curriculum that led to a sweeping overhaul of the position of the

PHOTOS: MIT MUSEUM



PHOTOS: *BOSTON HERALD*; MIT MUSEUM

Jerome Wiesner

continued

humanities on this campus, to the establishment of MIT's School of Humanities and the offering of double majors in humanities plus science or engineering. A later manifestation of his commitment to the humanities and the arts was the founding of the Council for the Arts in 1970. He maintained an involvement in the council's work and personally recruited many of its most distinguished members, among them architect I.M. Pei, '40; art patron and philanthropist Vera List, donor of MIT's List Gallery; and actress Kitty Carlisle Hart, chair of the New York State Council on the Arts.

In his mid-seventies, with successful careers in science, education, and government behind him, Wiesner survived coronary bypass surgery and battled back from a severe stroke—overcoming, with characteristic single-mindedness, its effects on his speech and mobility. Undaunted, he pursued with all the vigor that his doctors would allow the business of a multinational, fund-granting organization he helped to establish, ambitiously named the International Foundation for the Survival and Development of Humanity. Among the board members was Andrei Sakharov, the Soviet dissident and winner of the Nobel peace prize.

As recently as February 1993, he collaborated with two other MIT scientists known for their contributions to arms control, Institute Professor Philip Morrison and Principal Research Scientist Kosta Tsipis, in calling for deep cuts in U.S. military expenditures. They published their proposals in a provocative booklet, "Beyond the Looking Glass: the United States Military in 2000 and Later."

Jerry Wiesner was born in Detroit in 1915 and grew up in the working-class community of Dearborn. During his boyhood years, radio broadcasting underwent explosive growth, and telephones were a new technology. Wiesner exhibited an early fascination with communication by rigging up an unofficial neighborhood telephone system.

That background helped mold his student days at the University of Michigan at Ann Arbor, where he received a BS in mathematics and electrical engineering in 1937 and a master's degree in EE in 1938. Drawn to the technical side of Michigan's fledgling student radio station, he served as its associate director during both his undergraduate and graduate years. (Another student staffer at the radio station was television interviewer Mike Wallace.)

As a graduate student in acoustics, Wiesner was called on to engineer the remote live broadcast when Archibald MacLeish, then the librarian of Congress, presented a lecture at the university. In 1939, such a broadcast was a major technical undertaking, and MacLeish was impressed with Wiesner's expertise. The following year, he offered Jerry the chief engineer's position in the Acoustical Record Laboratory of the Library of Congress.

In September 1940, with his new bride, fellow Michigan math major Laya Wainger, Wiesner moved to Washington, D.C., where he developed advanced recording facilities for the library. As a part of the work, he traveled through the South and the Southwest with noted folklorist Alan Lomax, recording folk music of the regions using mobile equipment that Wiesner had built and installed in the trunk of a car.

The entry of the United States into World War II was to put more compelling demands on Wiesner's skills. MIT had launched the Radiation Laboratory in 1940 to press the development of military radar. One of the laboratory's early recruits was Louis Smullin, now MIT professor emeritus of electrical engineering, who had been an undergraduate friend of Wiesner's at Michigan. At Smullin's urging, the late Jerrold Zacharias recruited Wiesner as well.

Wiesner worked on microwave generation and signal processing phenomena at Rad Lab, later becoming a group leader himself, working on airborne radar. One such system, Project Cadillac, was to have been a network of radar systems that would keep track of the

AT EASE among students (above in 1972), Wiesner was personally committed to many of the issues around which the young were rallying in the 1960s and '70s: In 1973, John Bynoe of the federal Office of Civil Rights acknowledged that MIT's Affirmative Action Plan exceeded the standards of compliance. In October 1969, as provost, Wiesner participated in an anti-Vietnam War march to the Boston Common. Far right: undaunted by the turbulent times, Jerry celebrated his inauguration as president in 1971 with his wife, Laya.

PHOTOS: MIT MUSEUM

thousands of aircraft that the U.S. high command anticipated using in the event of an invasion of the Japanese main islands. When Rad Lab was phased out in October 1945, Wiesner spent a year at the University of California's Los Alamos Laboratory in New Mexico, working on electronic components for hydrogen bombs, his personal introduction to weapons of cataclysmic destructive power.

In less than a year, he was back at MIT, as an assistant professor of electrical engineering and a staff member at the Research Laboratory of Electronics, the successor to Rad Lab. Wiesner progressed rapidly at MIT: he was promoted to associate professor in 1947 and professor in 1950, the same year in which he received a PhD in electrical engineering from Michigan. Also in 1950, Wiesner was appointed associate director of RLE and saw the first doctoral degree awarded to one of his graduate students.

Edward David, ScD '50, who went on to become executive director of research for Bell Labs and president of Exxon Research and Engineering Co., says he was indelibly stamped with his young professor's "taste for excellence. Jerry thought it was always possible to do things better, more creatively." When David himself was named presidential science advisor in 1970, what he found most moving was the fact that he was following in Wiesner's footsteps.

Wiesner moved up to director of RLE in 1952, a post he held for nearly a decade—one of the most memorable periods in the Institute's history. Early on, he had joined an intellectual circle around the storied Norbert Wiener, professor of mathematics, whose seminal book, *Cybernetics, or Control and Communication in the Animal and the Machine*, was to have profound effects on scholarly thinking in the communications and computational sciences. His long-term association with Wiener heightened Wiesner's growing awareness of analogies between electronic signaling systems and communications in living systems—in vision, speech, hearing, and neurological and brain functions.

In pursuit of these connections, Wiesner and his colleagues brought to the laboratory a pantheon of powerful minds from diverse backgrounds—electronics engineers, computer scientists, theorists in information transmission and processing, mathematicians, linguists, neurologists, psychologists, audiologists, economists—for whom concepts of information theory, coding, feedback, prediction, and filtering opened new pathways to explore.

"We shared the ferment and excitement of discovering for ourselves the universal roles of communications processes in man's universe," Wiesner would recall later. "Fired up by Norbert Wiener's cybernetics, we explored the far-ranging implications of the concepts of information and communication theory."

Wiesner's own contribution to this ferment was enormous, but subtle, remembers Professor Emeritus Jerome Lettvin, recruited to RLE from the University of Chicago in 1951 to work in electrical engineering and physiology.

PHOTOS: MIT MUSEUM; *BOSTON HERALD*

Jerome Wiesner
continued

"Jerry was a catalyst for thinking," Lettvin says. "He asked the critical questions —he was a master at that." It was a trait that was to mark Wiesner all his life.

As an engineer in the late 1940s and early 1950s, Wiesner focused on over-the-horizon radio transmission by means of ionospheric scatter and on what was to become known as spread-spectrum communications. At MIT's Round Hill Experiment Station in South Dartmouth, Mass., he and his colleagues conducted experiments on how long-distance radio transmissions, such as the European broadcasts by Voice of America, might be made jam-proof.

At the same time, Wiesner was collaborating on federal studies of how the North American continent could be defended against attack by fleets of bomber aircraft. Wiesner's contributions were drawn from his work on the Japanese invasion problem and over-the-horizon radio transmission. As a result of these studies, the federal government asked MIT to establish Lincoln Laboratory in 1951 to develop a continental air-defense system. An early outcome was the Distant Early Warning (DEW) Line of integrated radars stretching across northern Canada.

In mid-1954, Wiesner was among university scientists and engineers participating in a secret national study on how the United States could defend itself against surprise attack. Commissioned by President Eisenhower, the group was known as the Technological Capabilities Panel; its chair was the late James R. Killian, Jr., '26, then president of MIT.

Eisenhower appointed Wiesner to be staff director for a panel convened in 1957 by New York attorney H. Rowen Gaither, Jr.—the Gaither Panel—to study the country's ability to defend large populations during nuclear attack. One result was a growing body of evidence that nuclear wars simply cannot be won. It was in this context that Wiesner was drawn to issues relating to the control of nuclear weapons, to the prevention of nuclear war, and, ultimately, to international nuclear disarmament. He was quickly given an opportunity to broaden and refine his thinking on these issues.

More than 40 years of MIT leadership, the presidents in the years 1949–90 (top, from left): Julius Stratton, Jerome Wiesner, Paul Gray, James Killian, and Howard Johnson. It was physicist Jerrold Zacharias (left, immediately above), then a group leader at the Radiation Laboratory, who first brought Wiesner to MIT in 1942. Zacharias and Wiesner are pictured with Alfred Poté, '26, executive vice-president of Hermes Electronics, inspecting a new airborne oscillator the company developed for such applications as satellite navigation.

When Soviet Union launched *Sputnik* later in 1957, Eisenhower's response included the appointment of Killian to the new post of special assistant to the president for science and technology. One of Killian's first acts was to establish the President's Scientific Advisory Committee, PSAC, with Wiesner as one of the first appointees. Wiesner's particular areas of expertise were welcomed within PSAC subpanels assigned to problems of nuclear armament, missile delivery systems, and military communications. In later reflections, Wiesner said it was his PSAC service that crystallized his thinking about the unwinnable nature of nuclear war.

In December that same year, the Soviets proposed a temporary ban on all atmospheric nuclear testing. Wiesner supported the ban, and he served on the PSAC panel charged with advising the president on its advisability—then the center of heated national debate. Some critics questioned the propriety of a scientific panel advising on an issue that was deemed primarily political. Even a PSAC member, Herbert York of the University of California, harbored such reservations.

"In short, my view was the common one," York said later in a letter to Killian, "to the effect that it was the scientist's job to discover what the technological possibilities inherent in nature were, and the politician's job to decide what to do with them.

"Jerry Wiesner told me simply and flatly that there was no one else who either would or could cope with this problem," York went on, "and whether or not a science-oriented group was the ideal forum, it was the only forum that had any chance of doing the right thing. I mulled that over . . . and decided he probably knew what he was talking about."

In early 1958, Wiesner was appointed staff director for the U.S.

PHOTOS: MIT MUSEUM; NEWS OFFICE/CALVIN CAMPBELL

delegation to what became known as the Geneva Conference on the Prevention of Surprise Attack. The same year saw Wiesner first become associated with the Pugwash Group, an informal organization whose activities were directed toward improving communications between intellectual leaders in the Communist bloc and Western nations. Through Pugwash, Wiesner became acquainted with some of the foremost scentific figures in the USSR.

The 1950s also saw a blossoming of Wiesner's friendship with John F. Kennedy, then a U.S. senator. Wiesner frequently provided informal advice to Kennedy on the scientific or technical aspects of various national issues. When Kennedy took office as president, he named Wiesner as his science advisor and chair of PSAC.

Early in the Kennedy administration, Wiesner helped the president enact the law that created the U.S. Arms Control Agency. It was the first time that there would be a branch of the federal government devoted specifically to curbing the arms race. In addition, during Wiesner's term on the White House staff, the United States and the USSR reached their first agreement on nuclear weapons—the limited Nuclear Test Ban Treaty, signed in 1963.

Not all Wiesner's White House efforts ended in success. Like many scientists, Wiesner believed that sending instrument packages into space was a more cost-efficient strategy to gather scientific knowledge than piloted space flights. Despite Wiesner's advice—and the advice of PSAC—Kennedy, after only a few weeks in office, made Project Apollo a national goal. Wiesner's influence can be seen, however, in the fact that the president always couched his rationale in terms of national prestige and the fulfillment of a national sense of adventure, and he carefully avoided any mention of advancing pure science.

In 1962, at the urging of Wiesner and PSAC, President Kennedy created an Office of Science and Technology in the executive branch of government, with the presidential science advisor as its director. By defining the science advisor as more than a member of the president's personal staff, Kennedy removed the shield of executive privilege. Congress was then free to call for Wiesner's testimony, a step that previous science advisors and many members of PSAC supported.

After the Kennedy assassination, Wiesner continued on at the White House under President Lyndon Johnson for a few months, returning to MIT in February 1964 to become dean of science and later provost under President Howard Johnson. In 1971 Wiesner succeeded Howard Johnson as president.

Among the advances that Wiesner influenced during his tenure as dean, provost, and president, were MIT's collaboration with the Harvard Medical School to create the Harvard-MIT Division of Health Science and Technology and the creation of the MIT Program in Science, Technology, and Society, both of which were reflections of his concern with the human condition and the role of technology in society.

The years from 1968 through 1973 were marked by student protest. Expressing their abhorrence of the Vietnam War, students staged demonstrations demanding an end to war-related research, greater student participation in university governance, liberalized courses of study, and university aid for the needy, the homeless, and the hungry. In complete harmony with Archibald MacLeish's view of him as a competent friend and bold companion to youth, Wiesner refused to regard students as "enemies" or to dismiss their demands out of hand. Together with other members of the administration and faculty, he engaged in a dialogue with the student leaders, with small groups, and with the student body as a whole in a one-day symposium in Kresge Auditorium. In creating a climate of mutual respect, they succeeded in diffusing much of the student anger.

During this period, Lincoln Laboratory, originally famed for air defense, was retained, but its research was redirected. The Instrumentation Laboratory, a leader in missile-guidance systems, was split off as an independent organization and renamed for its founder, Charles Stark Draper, '26. An MIT Commission on Education, headed by mathematics professor Kenneth Hoffman, in 1970 introduced sweeping changes in course and degree requirements. In the end, MIT emerged from those times intact, cohesive, and renewed.

Of equal importance during these years was Wiesner's leadership in the national debate over antiballistic missile systems, which he strongly opposed. With Harvard's Abram Chayes, he co-edited the 1969 book, *ABM: An Evaluation of the Decision to Deploy an Antiballistic Missile System*. Such resistance contributed to the signing of a 1972 treaty with the Soviet Union banning ABMs.

Upon his retirement from the presidency of the Institute in 1980, Wiesner eschewed the post of chair of the Corporation, although he continued to serve as a Life Member. Instead, he resumed the role of Institute Professor, continuing to learn and to teach. He devoted himself to arms control and the ban of weapons of mass destruction. These were topics on which he lectured and led seminars at universities around the country, seeking to inculcate his passionate concerns in the next generation of leaders.

Another concern of his post-presidency years was the development of what came to be called, with his input, "media arts and sciences." The phrase describes a field that was barely recognized as a discipline in 1977, when Wiesner began visiting MIT's Architecture Machine Group. Known in MIT parlance as ArchMac and headed by Nicholas Negroponte, '66, MAR '66, the group was trying to find new ways for people to employ and interact with computers. Finding there a new home for his lifetime love of communication, Wienser became, in the words of Paul Gray, "the intellectual champion" of Negroponte's group, now evolved into the Media Laboratory. Weisner helped build the laboratory by recruiting some of its most distinguished members, such as hologram master Steven Benton, now the Allen Professor of Media Arts and Sciences and head of the graduate program.

It was Wiesner who taught him "that almost nothing is as important as good ideas," and that "there is a lot more money in the world than good ideas," Negroponte says. But they both knew that it takes money to make things happen. They traveled the world to raise the $25 million needed to put up a

building for the Media Lab, one year spending more time with each other than with their respective wives. It was more than a routine honorific, then, when the new building—designed by I.M. Pei—was named for Jerry and Laya Wiesner.

Laya Wiesner had her own effect on the environment at MIT, and not only as a backup system for her spouse and mother of their four children. She was the driving force behind efforts to encourage girls in middle and high school to study math and science and think of studying at institutions like MIT. Now, with a freshman class that is 40 percent female, the impact of those efforts is incalculable. The passion for civil rights that she shared with Jerry was acknowledged in the *Boston Globe* editorial mourning his death. And she is recognized every year in the presentation of the Laya Wiesner Award, which goes to the graduating senior woman who has made the greatest contribution to campus life.

Wiesner was a much-honored figure and an oft-sought counselor: a trustee of the John D. and Catherine T. MacArthur Foundation, a governor of the Weizmann Institute of Science in Israel, and a member of the Board of Overseers at Harvard University. He was a Fellow of the American Academy of Arts and Sciences and the Institute of Electrical and Electronics Engineers, and a member of the National Academy of Science and of the National Academy of Engineering. He held honorary degrees from several universities, including Michigan, Brandeis, Harvard, Williams, Notre Dame, and Pennsylvania. The governments of the United States, Colombia, Japan, and Pakistan honored him with medals and awards. He was an honorary member of the Association of Alumni and Alumnae of MIT and recipient of the Association's highest honor, the Bronze Beaver.

"With Jerry Wiesner's death, the world has lost a great educator and scientific statesman, MIT has lost a memorable leader, and I have lost a personal hero," President Vest said. "We will all miss him. "

A memorial service is scheduled at MIT on Dec. 2. □ —*ROBERT BYERS was the director of the MIT News Office from 1970 to 1987.*

ALC REPORT

Academics as World-Class Listeners

BY LISA WATTS

RICHARD LESTER

MARK WRIGHTON

DAVID LITSTER

Richard Lester, PhD '80, knows that the winds of change are blowing through industry. He has seen how new technologies, increasing competition, and tight resources are shaking up everything from how managers make decisions to how innovations take shape. What once was a linear process, from lab bench to prototype to marketing, is now more of a network, drawing on ideas from far outside the lab to launch new products.

If industry is changing, universities need to flow with some of those wind shifts to better prepare future engineers, scientists, and managers, Lester told the several hundred participants at the annual Alumni/ae Leadership Conference (ALC) in late September.

Lester, professor of nuclear engineering and director of MIT's Center for Industrial Performance, cited other equally pressing indicators of the need to build a university/industry alliance. With government funding for defense research in a post-Cold War decline, research universities must look to industry for sponsorship and collaboration. And with industry challenged by global competition and leaner times, university expertise is a resource companies are tapping just to stay in the game.

Building the industry/university partnership, how it works, and where it gets complicated were the topics of the ALC, a day of intellectual renewal and recognition that the Alumni/ae Assocation hosts annually to honor its most active volunteers. Lester was joined on the program by eight other members of the faculty and staff who lead projects ranging from moving innovations into production to fellowship programs for mid-career managers.

Panel members noted that the development of "useful knowledge" has been a strength of MIT's since its founding, giving the school an edge in the new arena. "Today, universities have to get

PHOTOS: L. BARRY HETHERINGTON

relevant, meaning economic relevance," said Provost Mark Wrighton, who with Vice-President for Research David Litster moderated the forum. "I believe MIT is better situated than any other institution to contribute to the country's economic strength," Wrighton said.

Nodes in a network

Lester proposed a new model for thinking about the relationship in question:

"The university is not at the upstream end of the [innovation] process," he said. "Think of universities serving as nodes in a national network, with information flowing in both directions with industry. Research universities would keep their primary mission of education and research, but they would be involved in all aspects of research and development" in the larger world.

To create such a network model, "we need to become world-class listeners," he said, admitting that's a revolutionary notion to some members of the university community.

Lester told of a recent visit from an IBM technical officer, who described how the changing nature of R&D affects hiring. "Habits of thought are changing, research agendas are no longer set by peers," Lester was told. "Researchers must be able to build internal and external alliances. He said IBM needs more worldly people . . . not monks on the hill but Franciscans out on the street. And this isn't what we're turning out of our graduate schools."

What's working well

John Preston sees the Technology Licensing Office that he directs at MIT as an "agent of change" in the relationship between universities and industry. Moving from an earlier era of faculty "collecting patents like stamps," Preston's office has helped faculty license their inventions to industry as well as patent them, speeding technology transfer and creating dozens of start-up firms along the way.

"We are looked to as a model of how to do this," Preston said. "We are the number-one university in deal flow and royalty income. Our numbers—two inventions coming in every day, with a 60 percent chance of being patented or licensed within a year—are about comparable with the federal government."

David Staelin

Thomas Magnanti

John Preston

Alan Davison

The Institute's policy of allowing faculty to take shares of up to 20 percent in firms that license their innovations (while adhering to conflict-of-interest guidelines) jump-started the tremendous volume of technology transfer in the last 10 years. TLO staff say such transfers advance the country's health, safety, and competitiveness, rather than leaving breakthroughs to collect dust on a shelf. Panelist Paul Schimmel, PhD '67, professor of biochemistry and biophysics, said that in the world of venture capitalism, which is critical to the fledgling field of biotechnology, "TLO's reputation is outstanding."

While the TLO office helps funnel MIT faculty research to industry, the New Products Program headed by Woodie Flowers, PhD '73, helps bring the manufacturing world to students. Since 1991, Flowers, who is the Pappalardo Professor of Mechanical Engineering, has guided students through the design and construction of a new Stanley power tool and a blood-analysis system, and they have a machine in the works to help builders hang wallboard. He showed slides of a recent class that designed and built three different prototypes of a riding lawnmower. The work requires daily interaction with industrial professionals as clients, Flowers said, and introduces student teams to issues of confidentiality, property rights, deadlines and responsibility, and budgets—as well as basic design and assembly. The result, Flowers said, is graduates who are better equipped to lead product-development teams. *(See "Engineering Education Gets Real" by William K. Durfee, February/March 1994.)*

David Staelin, '60, ScD '65, presented MIT's Lincoln Laboratory as another example of the Institute's successful integration with industry. Staelin is the assistant director of the lab as well as a member of the faculty in electrical engineering and computer science. He said that Lincoln's mission since its creation in 1951 by the Department of Defense has been to conduct "pre-competitive technology development" in surveillance and communications. Ninety percent of its funding has come from the U.S. Air Force, but Staelin described several consortia developed with industry and

ALC REPORT

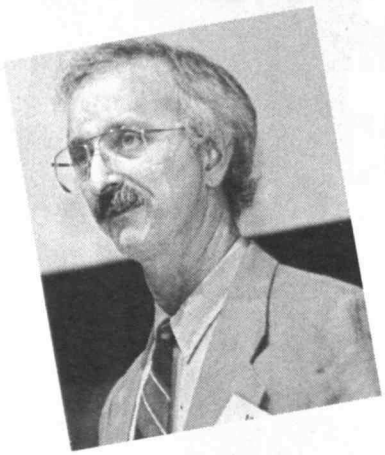
Academics as World-Class Listeners

continued

said 63 companies have spun off from Lincoln Lab, including Digital Equipment Corp. and MITRE.

Alan Davison, professor of chemistry, offered one last example of successful collaboration. Davison and his graduate student, Michael Abrams, PhD '83, were studying the radio-active element technetium when they devised a compound that mimics biological function. Working with researchers at the Harvard Medical School, they conducted tests that led to a licensed product, Cardiolite, used to detect dead or diseased heart-muscle tissue in cardiac patients.

Cardiolite is now the top income-producer for MIT and Harvard, with MIT's share of the annual royalties coming to about $2 million. "Very few academic institutions develop new drugs, so we can be very proud of this," Davison said. "It's one of the best examples of a small research lab collaborating with a pharmaceutical company." Also a source of pride for Davison is the fact that the industrial development of the new drug at Dupont-Merck was supervised by another of his students, Timothy Carrol, PhD '84.



WOODIE FLOWERS

PAUL SCHIMMEL

PART OF THE PROBLEM, AND THE SOLUTION

A number of recent programs at MIT bring mid-career professionals from industry to campus for degrees or certification. The managers leave with better grounding in their fields, but faculty are educated as well, gaining insight into issues and processes in commercial labs and plants.

Thomas Magnanti said the Leaders for Manufacturing Program was launched in 1988 out of the "feeling that we at MIT were part of the manufacturing problem in this country." He noted that nationwide, 70,000 MBAs graduate every year along with 70,000 engineering undergraduates. "But these systems aren't linked with each other." said Magnanti, the George Eastman Professor of Management and co-director of the Operations Research Center. "We educate generically. We think our new managers can run a McDonald's or a Boeing, that they don't have to know the technology."

To address that deficiency, Magnanti and collaborators from both Sloan and the School of Engineering, together with major industrial partners, created the Leaders program, in which participants spend two years on campus gaining a foundation in product and process design and manufacturing policy. "Then we try to teach them leadership, the elusive butterfly," he said.

Of the program's 181 graduates, 141 have gone on to work in manufacturing plants. "That's an important number, because only about 5 percent of business school graduates [typically] go into manufacturing," he said. "It's a paradigm shift: MIT-caliber people working in manufacturing." A similar program, System Design and Management, is getting underway at MIT to address the needs of chief engineers for management education.

In the bigger picture, Magnanti wants to see all undergraduates given an opportunity to gain industrial experience through more "distance-learning" programs that put students on site. And he wants to see better integration of what he calls "18 to 80" education—from the undergraduate years throughout one's entire career. Many in industry share his convictions: he was told recently by a Motorola official that every company employee eventually will spend one month a year in education and training. Such a trend offers MIT great opportunities to educate more students and establish more company partnerships, he said.

Panel members noted that while they were in favor of better integration, they don't see university labs becoming arms of industry. Paraphrasing the philosopher Mencius, who said "friendship is one mind in two bodies," Magnanti said industry and universities must "have a single mind, learn to cooperate, but we've got to be in two bodies."

Richard Lester agreed. "The best alliances happen when everyone respects the fact that their interests don't exactly coincide," he said. A specific area in which university and industrial priorities may well diverge was noted by David Litster: the relative emphasis placed on basic science.

"The transistor, integrated circuits, biotechnology, computer networking—these all took a long time between the basic research and commercial exploitation," Litster said. "Where will we get the basic science and technology for our industries to exploit 20 years from now if we say we can't support something today unless we see an [immediate] end product?"

EXCELLENT PROSPECTS

Lester has held his finger to industry's changing winds since joining MIT's

The proud recipients of Bronze Beaver Awards (l. to r.): Harbo Jensen, John Kunstadter, Antonia Schuman, and Bennett Zarren.

Morgan Award-winning educational counsellors (l. to r.): Richard Howland, Gail Marcus, Michael Marcus, and Daniel Oliver.

Commission on Industrial Productivity in the late 1980s. In 1992, having published the landmark *Made in America* report on the status of this country's manufacturing industries, the multidisciplinary faculty commission formed the Industrial Performance Center to give MIT a continuing focus for research on manufacturing.

"We try to serve as a listening post, to make sense of the patterns and trends, interpret them for our industrial partners, and feed them back into our disciplines," Lester said. He has also held his ear to university campuses, where he has heard "a good deal of worry and despondency about what the future holds" for science and engineering education, "some of which is justified." But Lester is feeling bullish about the economy, education, and especially MIT.

"In spite of all this change, our primary mission remains as viable and valid as it ever was," he said. "We're fortunate to have a lot here that does work pretty well."□

ALC AWARDS

Kudos to Those Who Labor in the Vineyards

A high point of the annual Alumni/ae Leadership Conference (ALC), held this year in September, was the presentation of awards to individuals and groups whose service to MIT has been extraordinary.

The **Bronze Beaver**, which recognizes outstanding contributions over time to the missions of the Institute and the Alumni/ae Association, is the highest award that the alumni/ae body can accord one of its members. Fewer than 250 alumni/ae have been thus honored. This year, the distinctive beaver lapel pins and figures went to **Harbo Jensen**, SM '74, **John Kunstadter**, '49, **Antonia Schuman**, '58, and **Bennett Zarren**, '61. Jensen, an officer and president of the MIT Club of Northern California, has also chaired an Alumni/ae Fund Visit Program, been a member of the Fund Board, and served on the national campaign committee of the *Campaign for the future*. Jensen's service to MIT is all the more notable in the face of his demanding schedule of business travel. Kunstadter, a longtime leader of the MIT Club of New York and veteran class officer and educational counsellor, also has distinguished himself in a number of fund-raising activities, notably the MIT Leadership Campaign, the Class

ALC AWARDS

Kudos

continued

Lobdell Awards went to (from left): Ronald Fergle, George Beesley, Emmanuel Ikpo, Dale Krouse, Ronald Kurtz, and Jorge Rodriguez.

of '49 Reunion Gift Committees, and the Corporation Development Committee. He is the present chair of the MIT Council for the Arts. Toni Schuman's alumnae career opened with 20 years as assistant secretary for her class, and she is approaching 30 years as a member of the Educational Council. She was the first woman to serve as president of the MIT Club of Southern California, helped found the AMITA chapter in her region and worked in its high school visit program, has been an active fund raiser, and served as a member of the Board of Directors and as Alumni/ae Association vice-president. Zarren's alumni involvement began as a network-building 25th reunion chair of his class. He went on to head three separate efforts under the Alumni/ae Fund Visit Program, served on the Fund Board and the Association Board of Directors, and actively supports students engaged in MIT's human-powered underwater vehicle project.

The **Lobdell Awards** acknowledge service of special depth over a sustained period. The award is named for Harold E. Lobdell, '17, the founding executive vice-president of the Alumni/ae Association. The 1994 recipients are **George Beesley**, '39, **Ronald Fergle**, SM '86, **Emmanuel Ikpo**, SM '83, **Dale Schain Krouse**, '71, **Ronald Kurtz**, '54, and **Jorge Rodriguez**, '60. Four decades of volunteer support earned this honor for Beesley, who has served his class as president, reunion chair, and 50th-reunion-book editor. He has also worked on the Personal Solicitation Program and on the Technology Day Committee. Fergle has held almost every post in the MIT Club of Chicago, including three years as president. He is an educational counsellor, telethon solicitor, and member of the Technology Day Committee and the Association Board. Ikpo is a longtime member and former president of the MIT Club of Washington, D.C., a telethon solicitor, and an active mem-

Representatives who received Presidential Citations on behalf of their winning groups (from left): Noel Bartlett for the MIT Club of Northeast Ohio; James McDonough for the Class of '43 50th Reunion and Gift Committees; David Park for the Student Alumni/ae Council; and Joan Roth and Jorge Rodriguez for the MIT Club of Boston.

Kane Award recipients (from left) Steven Finn, Helmut Weymar, and Richard Simmons.

ber of BAMIT and of the National Selection Committee, which names the officers of the Association. Krouse has been a tireless officer in the MIT Club of Northern New Jersey, where she implemented a number of cost-saving measures and organized outstanding programs. She is a regional chair of the Educational Council and met with great success when she reinstated a breakfast meeting between area high school guidance counsellors and MIT Director of Admissions Michael Behnke. Kurtz, who is a nine-year veteran of the Corporation Visiting Committee to the Department of Materials Science and Engineering, has 15 years of service as an educational counsellor behind him. He was 40th Reunion Gift Chair for his class and a solicitor for both the Leadership Campaign and the *Campaign for the future*. Kurtz has also been very active on behalf of the Council for the Arts, including helping to create fellowships in the arts and chairing the MIT Museum Advisory Board. Described as a driving force in the MIT Club of Boston, Rodriguez was a linchpin of last year's highly successful Science Auction Gala at the Boston Museum of Science (winner of an award in its own right.) President and 30th reunion chair of his class and chair of the 1994 Technology Day Committee, Rodriguez is known for his thoroughness, humor, and vitality.

The professionalism, attention to detail, and care for their interviewees shown by members of MIT's Educational Council make the Council an indispensable arm of the Admissions Office. The **George B. Morgan, '20 Award,** named for a prototypical educational counsellor and the first honoree, recognizes that professionalism, often over a period of decades. The '94 recipients are **Richard Howland,** '62, **Gail Marcus,** '68, **Michael Marcus,** '68, and **Daniel Oliver,** '60. Dick Howland, counsellor since 1972 and chair for the Pittsburgh region since 1979, hosts a yearly gathering for admitted students. A meticulous record keeper, he extends his coverage into the rural areas outside

ALC AWARDS

Kudos

continued

his region and has helped the Council use computer technology to communicate with its members. Gail Marcus is a 22-year veteran of the Council who serves the Washington region. She is the first woman to receive a Morgan Award and consistently conducts more interviews than the average counsellor. Mike Marcus, on the Council since 1975, has visited a wide variety of schools and substantially increased awareness of MIT. With Gail he has been co-chair of the Montgomery County subregion since 1982, making it one of the most cohesive subregions in the capital area. A veteran of 15 years of Council service, Dan Oliver has chaired the San Diego region since 1988. He is a superb organizer, never more so than when he arranges an annual meeting between newly admitted students and members of a visiting MIT athletic team. On his visits to campus, he often meets with "his" students, and he follows their careers with interest.

The **Henry B. Kane '24 Awards** recognize outstanding effort in fund raising—a core activity for Association members — and are named for a particularly energetic and influential director of the Alumni/ae Fund. This year the awardees are **Steven Finn**, '68, **Richard Simmons**, '53, and **Helmut Weymar**, '58. As 25th reunion-gift chair for his class, Steve Finn recruited an outstanding committee, maintained close communication with Alumni/ae Association staff, and earned much of the credit for a fine gift and wide participation by classmates. The most recent fund-raising achievement of Corporation member Dick Simmons was chairing his 40th Reunion Gift Committee. But he also has a long history as a solicitor in the Leadership Campaign in the 1970s and as chair of the regional National Campaign Committee for the *Campaign for the future* in the 1980s. A member of the Corporation Development Committee, Weymar worked hard on the *Campaign for the future*, hosting cultivational events and soliciting fellow grads and friends. His special interest is in the Department of Economics, where he played a key role in building the endowment for the Paul Samuelson Professorship.

A key factor in the continued vitality of the Association is the number of projects that owe their success to team efforts. It is such collective achievements that are recognized by **Presidential Citations**. Honored this year were the **Class of 1943 50th Reunion**, the **Student Alumni/ae Council**, the **MIT Club of Boston**, and the **MIT Club of Northeast Ohio**. The 50th Reunion of the Class of '43 broke all previous records. Organizers planned and executed a flawless program that attracted 30 percent of classmates, assembled more than 100 members to march at Commencement, and hit their ambitious targets for reunion-gift participation and dollars. The seminar on entrepreneurship set up by the fledgling Student Alumni/ae Council in November 1993 drew a sell-out crowd, and the organizers impressed panelists with their professionalism and leadership ability. One of their goals is creating career-related events, and the seminar was an extraordinary first step. The MIT Club of Boston conceived and organized an auction at Boston's Museum of Science that drew more than 400 festive attendees (many in black tie), solicited close to 200 donated items, and raised $20,000 for MIT's Council for Primary and Secondary Education. One-day seminars held in 1990 and 1993, the most recent on "Materials: 2001," organized by the MIT Club of Northeast Ohio working with the Case Western Reserve Alumni Association, drew between 200 and 300 attendees. The seminars featured faculty members and local alumni as speakers and reflected the 18 months of planning—led by Norman Klivans, '40—that were required for each event. ■

MANAGING A VOLUNTEER-BASED ORGANIZATION

MIT's Alumni/ae Association was founded on volunteer effort, and volunteers remain the primary source of ideas and energy.

The key to our continued success is in understanding the special demands of managing an organization in which the processes of recuiting, organizing, motivating, monitoring, and leading people are grounded in their common sense of mission. The task we face—as a Board of Directors and an Association—is quite different from managing employees, where the authority and responsibility are much more clearly defined and where a commitment to the task at hand and to the organization is driven by financial compensation.

During the last couple of decades, the value of the Association and its programs to MIT has increased enormously. That value is a direct result of improved volunteer-based organizational managment, a unique distinction that should be a source of satisfaction to Association members.

The fact that managing in a volunteer environment is a demanding specialty is often underestimated. For example, it has been suggested that the Enterprise Forum, an Association activity that promotes entrepreneurship, might be more appropriately operated by some other branch of MIT, such as the Technology Licensing Office (TLO), which is in the business of licensing innovations that are of potential interest to entrepreneurs.

Those who make this suggestion overlook the critical importance of the vol-

unteer factor in running the Enterprise Forum. In the case of the TLO, it is the national leader in moving new technology from the university laboratory to the market. But like other branches of MIT that have been proposed as overseers of the Forum, it has little or no experience with the unique demands of a volunteer-driven organization.

The Forum, transferred to the care of an inexperienced "parent," might find the parenting skills lacking, in spite of the shared audience and focus. I maintain that the volunteer nature of Association activies such as the Forum is the most important factor in determining a home for those activities.

MIT, and alumni/ae organizations in general, are not alone in fostering volunteer-based structures. There are health organizations such as hospitals, service agencies such as the Red Cross, political groups, bodies that promote the arts and protect the environment—all making intelligent use of the energy of volunteers. Many members of the Association find that there is a cross-fertilization between their work for MIT and their other volunteer commitments.

In our own Association, overall direction and policy are determined by the set of volunteers who serve as officers and directors, while day-to-day management is in the hands of volunteers who head groups such as local clubs and branches of the Forum, generate the Class Notes in *Techology Review*, serve unique constituencies such as AMITA and CAMIT, plan Technology Day and reunions, and organize fund-raising activities. The Association staff provides the support that binds all these efforts together and helps to keep them innovative, focused, and closely linked to the Institute.

Leaders of the Association need to recognize that the better we understand our organization and how to make it work, the better the results that we will achieve. Since volunteers make up the vast majority of our structure, management of their effort should be our primary focus and offers us the widest possible arena for improvement.

Since volunteers make up the majority of the Alumni/ae Association structure, management of their effort offers the widest arena for improvement in operations and should be our primary focus.

Further, it is in the nature of a volunteer-based organization that today's new recruit could be proposing and heading a new project tomorrow, so awareness of the special demands of volunteer structures must be widespread. This is not a concern limited to a small group at the top of some organizational pyramid.

It is also essential that we delineate the character of a volunteer organization and its value to the Institute, so that MIT's administrators can work with the Association in the most effective way to promote overall institutional goals.

What are some of the elements of effective management in this environment?

- Provide a strategic focus in the form of a well-defined organizational mission and set of objectives.
- Recruit the ablest volunteers as leaders and help define their responsibilities to fit within the time and resources they have available.
- Continuously follow up with key volunteers on every activity, to monitor progress, offer support, and exchange explicit feedback.
- Provide staff support as the essential but unobtrusive glue that holds a project or group together.
- Develop a system for recognizing and honoring volunteer efforts that takes into account both escalating levels of achievement and long-term commitment.

These are some of the guiding principles that we have learned through experience with Association activities rather than a general theory of volunteer-based organizational management. Any feedback you, as members, can provide from your volunteer service at MIT or elsewhere would be welcomed by the Board of Directors as we continue to hone the Association management.

R. Gary Schweikhardt

R. GARY SCHWEIKHARDT, SM '73, President, Association of Alumni and Alumnae of MIT.

Note: Alumni/ae can send messages to Gary at 1-(800) MIT-1865 and at <mitalum@mitvmc.mit.edu>.

ClassNotes

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A delightful phone call took 1921's best wishes far west to **Arthur N. Brambach**, engineering administration, at the romantic home address of 1920 Tam Oshanter Blvd., Bellevue, WA 98008-3240, where a grandson completes a family duo since Art lost his wife several years ago. Art tells us that one of his retirement jobs is driving to get household supplies. He notes that his son lives in our region in Valley Stream, Long Island, N.Y.

We have a most pleasant recollection of Art's taking us on a grand tour of San Francisco, where he was working during our first visit there, and steering us to the "Top of the Mark" to see the awesome beauty of the sun setting on the Golden Gate. At the time, Art said that on the previous day he had attended a meeting of the local MIT Club which, unfortunately, we missed. Now Art adds that he has lost contact with '21ers, who seem to visit his area infrequently. Call him if you plan to be in the vicinity—he has a wealth of knowledge of the West Coast.

A happy phone conversation with **Sumner Hayward**, chemical engineering and 1921 secretary-treasurer emeritus, continued a long-standing semi-annual series of congratulatory messages on our respective birthdays. He had arrived exactly six months to the day prior to your scribe's debut on February 12, 1900, in the last year of the 19th century. We congratulate each other because, legally, the age-to-nearest-birthday advantage may permit sharing the same figure. Any reaching the year 2001 could bring three-century status!

Sumner tells us he "feels wonderful" and is "expecting to live to 100." He adds that "life is good" and "all is OK" with him. He is near his daughter, Priscilla, and frequently sees his granddaughter, Marcella, and a 3-year-old great-granddaughter, Samantha.

We had a laugh over the public's intention to celebrate the arrival of the new century one year too early—on January 1, 2000, ignoring, as does the media, that there is no year numbered zero. Initially, the new numbering system had to go from 1 BC to year AD 1, requiring a full 100 years to greet the second century at year 101—a number without distinction—and so it has been over the centuries. All hail to January 1, 2001, and farewell to year 2000 and the 20th century!

We had the pleasure (and surprise) of contacting another onetime "junior freshman" of our class, namely, Dr. **O. Kenneth Bates**, mechanical engineering, through bachelor's, master's and ScD degrees. . . . Renewing these contacts during so many years of preparing Class Notes is always enjoyable. The surprise was that Ken, like **Arnold R. Davis** (*Technology Review*, Nov/Dec 1994), also volunteered that he had entered MIT via the "junior" route, the first two to do so during our years of reporting.

By way of explanation, we should note that there never was any public listing of the junior freshman group by MIT nor any separate treatment of its members, so that after our first year at the Institute none of us ever recalled just who was in the group. Any pride they may have shown must have been the result of being the first to have had and successfully enjoyed their unusual experience.

As for Ken Bates, his story bears a striking similarity to what Arnie Davis told us several months ago, except for his professional occupation. Up to retirement, Ken had been Commings Professor of Mathematics at St. Lawrence University for many years. He acquired the title of professor emeritus on relinquishing the post. Ken also tells us that he is enjoying freedom from teaching routines and having fun sharing a life of ease with a younger member of his family. He tops it off with what he terms "reasonably good health."

Tell us if you wish to communicate with Ken personally or with any others (particularly to cheer up the shut-ins) and we will supply addresses and phone numbers as available.

If you have overlooked replying to our requests, remember that MIT is the permanent center of amity. Stop here to pen, type, or phone your secretary with retirement news and a true MIT-related story from the past for all of us to enjoy.—**Carole A. Clarke**, president and secretary, 608 Union Lane, Brielle, NJ 08730-1423, (908) 528-8881; **Samuel E. Lunden**, assistant secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 96274, (310) 833-1480

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Professor B. Zwiebach wrote to **Martha Munzer**, former class secretary, to again express his appreciation to the class for the Class of 1922 Career Development Professorship that he was awarded in July 1922 and to report on current activities. He writes, "This last year was a good one for me at MIT. I got promoted to the rank of tenured faculty in the Physics Department. Having now a permanent position at MIT, I can continue to pursue without worries my research in string theory. Access to the funds of the Career Development Professorship enabled me to invite scientists to MIT for periods of a month. These visits resulted in research papers I am very proud of. In particular, visits from Professor H. Sonoda of UCLA and Professor Ashoke Sen from the Tata Institute were instrumental in advancing towards the complete formulation of the equations that govern the behavior of strings. Finding these equations is an essential prerequisite to understand if string theory is the long-sought-after theory of all interactions."

There are three deaths to report. From his son, we learn that **Victor Kruse**, of Westfield, N.J., died last March, but we have no further details. . . . We thank Phil Blanchard, '24, for the following information. **Clift Richards**, of Altoona, Fla., retired construction engineer, died June 9, 1994. He was an Army veteran of World Wars I and II, a member of the First Congregational Church of Mount Dora, a Mason, and a member of the Kiwanis Club. Although there are no known survivors, Phil Blanchard writes, "I am sure he had a nephew call on him here at Lake View Terrace Christian Retirement Center, where I also live.". . . **James Munroe**, of Newton, Mass., and Wolfeboro, N.H., former owner of Munro Drydock and Ship Repair in Chelsea, died last March. He was 92. He leaves a wife, Violet.

Please send news for this column to: Class Notes Editor, *Technology Review*, MIT, W59, 201 Vassar St., Cambridge, MA 02139

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Miles Pennybacker submitted an article on Cuba that was printed in the April 28th issue of the *Minuteman*. Miles spent eight days in Cuba traveling by foot and taxi. According to Miles the buildings, roads, and streets are well maintained and the people appeared to be happy.

The October issue of the *Review* carried a six-page write-up about the life of **Julius A. Stratton** who passed away on June 22nd. I received notice of his death too late to include in the Class Notes for the October *Review*. Jay was an outstanding member of the class. If I remember correctly Jay and Kay attended all of our reunions, including the 70th. We were very fortunate to have had him as MIT's leader for seven years as president.

Another one of the "greats" of our class is **Cecil H. Green**. MIT has established a professorship in his name. Cecil, who founded Texas Instruments of Dallas, is one of the nation's leading innovators and philanthropists.

Leonard E. Carlsmith died April 11, 1994.—**Royal Sterling**, secretary, 2350 Indian Creek Blvd. W., Apt. D201, Vero Beach, FL 32966-5103

24

I have heard from the MIT Alumni/ae Association of the deaths of four classmates.

Hartselle D. Kinsey passed away July 9, 1994. The Scarsdale, N.Y., paper refers to him as "Sox" Kinsey. He was a retired VP of the Union Carbide Corp., who contributed to the Manhattan Project. He served as plant manager and general superintendent of the gaseous diffusion plant in Oak Ridge, Tenn., that produced the major component for the atomic bomb. His suggestions for simplifying procedures are credited with speeding production. He moved to New York after the war to head

Union Carbide divisions and later was VP of the company. After retiring in 1966, he served as a consultant with the International Executive Service Corps, where his duties included being a pollution control consultant. He had assignments in Taiwan and Iran.

Sox graduated from Roanoke College, received a master's degree in chemical engineering from MIT, and was awarded an honorary doctorate from Roanoke College. He married **Catharine Koontz**. She died in 1984.

He was active in Scarsdale as a member of the board of governors of the Town Club and was a past village trustee. He was also a trustee of Roanoke College for 25 years and was active in numerous other civic and professional organizations. He had 4 daughters, 12 grandchildren, and 10 great-grandchildren. Our sympathy to all the family.

Walter J. Bagby died April 7, 1994, after a brief illness, his daughter, Jane Bagby Cole, wrote. He was a retired Union Carbide engineer, and had two daughters, six grandchildren, and nine great-grandchildren. Condolences to all the family.

There were two alumni about whom I have little information. One is **Malcolm H. Finley**. He died this year and the last known address was in San Rafael, Calif. Anyone who could give the class more data on Malcolm would be appreciated.

The other classmate who passed away was **Malcolm S. MacNaught**. He was from Manchester, Conn., and died May 30, 1994.

Received a telephone call from **John Fitch**. He says he has given up on writing. The purpose of the call was to thank me for the pictures from the class reunion. So good to talk to him. The joy of that reunion was that I have made some more friends. When I asked John how he was doing, his comment was that he was hopping around on a cane but still playing golf!

We had our annual Artichoke Festival this past weekend in Castroville. It was lots of fun with the air of a carnival. We, of course, had to have some fried artichoke hearts. *But* let me tell you I have had my cholesterol for the month.—Co-secretaries: **Katty Hereford**, 237 Hacienda Carmel, Carmel, CA 93923; Col. **I. Henry Stern**, 2840 S. Ocean, #514, Palm Beach, FL 33480

25 70th Reunion

Several weeks ago a letter concerning the 70th Reunion was mailed to about 80 classmates for whom mailing addresses are available. I hope the letter brings a good response. Any classmates who haven't replied are urged to take prompt action. **Sam Spiker** reports that he was the sole representative of 1925 at the Technology Day Luncheon last June. The Alumni/ae Association personnel estimate the number will be 10 in June 1995. We should do better.—**F. Leroy (Doc) Foster**, secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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We are grateful to Marita (Mrs. **Harold**) **J. Ryan**, for information about her husband, who died August 8, 1994. After graduating from MIT, Ryan worked as an application engineer in power-plant design for copper mining and refining. In 1932, he received a master's degree in business administration from New York University. He then worked as supervising engineer for Frigidaire and in 1939 organized an air conditioning, engineering, and contracting company, Harold J. Ryan, Inc. in New York City. He remained its president until 1954 when he devoted his time to consulting engineering. His achievements include the air conditioning of the Waldorf Astoria, the Pan American Building, the New York City Subway System, and the Statue of Liberty.

As a resident of Poquott since 1940, he participated in many activities in that community. Aware of the potential air and thermal pollution of large power plants, he opposed the LILCO installation on Port Jefferson Harbor in 1946, and his participation in many public hearings contributed to the consciousness of the community to the need for pollution control. When the plant was built, it contained one of the finest dust control systems that had been installed in any power plant in that era.

Harold Ryan

Ryan received a distinguished service award from the American Society of Heating, Refrigeration, and Air-Conditioning Engineers for 50 years of service. He was responsible for the nine chapters of the society's *Guide and Data Book for Air Conditioning* , describing large-building air-conditioning systems and their applications.

He loved boating and was a member of the United States Power Squadron, an organization devoted to boating safety. Also, he had recently won an early aviation photo contest sponsored by Northwest Orient's magazine (*see feature this page*). Ryan leaves his wife of 62 years, Marita, four daughters, a son, twenty-five grandchildren, and two great-grandchildren.—*Ed.*

Temporarily, please send news for this column to: Class Notes Editor, *Technology Review*, MIT, W59-217, 201 Vassar St., Cambridge, MA 02139

Harold Ryan and the Flying Machine

When Northwest Orient Airline's magazine, Passages, *invited readers to enter their Early Aviation Photo Contest, the late Harold J. Ryan, '26, sent in the above photo and won (see Class of '26 column, this page). He stands beside a Curtiss "Jenny," a World War I trainer. Since an anecdote about the photo was to accompany the entry, Ryan sent the following story:*

"My first flight, February 14, 1925: The plane is a 'Jenny,' really a flying box kite, a spruce frame covered with canvas, the canvas then painted to shrink it to fit the frame. The 'Jenny' was a favorite among the stuntmen of that era. Its normal flying speed was only 80 mph (top speed, 100 mph in a dive), so there wasn't much wind resistance. You could wave a big hello to a passing plane with no trouble.

"It was an open-cockpit plane, hence the heavily fleece-lined winter flying suit, including lined helmet, gloves, and boots.

"We took off from a cinder strip in a field in East Boston, which is now part of Logan Airport. After climbing to approximately 3,000 feet, I was introduced to a 'loop' (a swooping dive), a 'volplane' (descending in large circles to deaccelerate for a slower landing speed), and a 'tailspin' (engine stalls and plane goes into an out-of-control spinning dive because of a too-steep climb).

"We climbed again and then dove at the main stack of an ocean liner in the harbor. For a moment, I thought I'd end up in its engine room. Once again at a safe altitude, the instructor signaled me to take the 'stick.' I will never forget the thrill I had of controlling that plane, somewhat erratically, to be sure, for the next 10 minutes before he again took control and brought us down on the bumpy cinder strip. That brought to an end my exciting introduction to the freedom of flight."□

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Glad to receive a note from **Thomas Knowles** in Naples, Fla. He says he is doing OK in the geriatric circuit and has just been given a pacemaker with a heartbeat rate setting that can get him through nine holes in two hours. Best wishes to Tom.

Harland P. Sisk of Yarmouthport, Mass., died June 20, 1994, after a long illness. He had been with General Electric for his entire career. Serving in several managerial positions in Schenectady, N.Y., and Pittsfield and Holyoke, Mass., plants, he returned to Pittsfield in 1960 as superintendent and later as general manager of the distribution transformer division until his retirement in 1967. Under his leadership, the division developed new designs that reduced the size of pole-type transformers, made them more attractive, and helped make progress in underground distribution systems.

True to MIT alumni tradition, after moving to Cape Cod Harland contributed greatly to community affairs. He was D-Y school district's first business manager from 1969 to 1970. He was a director of Cape Cod Chapters of American Red Cross and of the Service Corps of Retired Executives. He was also treasurer of the *Cape Cod Times* Needy fund for 13 years. Harland was also a member of the Cape Cod Conservatory, Cape Cod Symphony Orchestra, Appalachian Club, Yarmouth Art guild, and First Congregational Church of Yarmouth. He certainly led a productive and full life. We send our condolences to his widow, Louise, and family.

In the last issue of the *Review* we reported the death of **Arthur J. Tacy**. Thanks to his son, Peter B. Tacy of Mystic, Conn., we have some information on his life. Arthur died from complications resulting from Alzheimer's disease. An electrical engineer, Art joined General Electric and remained with them until his retirement in 1972. Originally a sales engineer, he became interested during the late 1930s in finding ways to accurately forecast the needs of GE's industrial and electric utilities customers. After service during the war on a board that oversaw distribution of strategic materials, he joined GE's newly formed market research operation. In 1950 he was assigned to a team charged with reorganizing the corporation to be more responsive to market opportunities. The "decentralization" plan this team developed transformed GE into a complex of semi-autonomous units or "profit centers," all of which could function as entrepreneurs.

Art joined GE's executive office in New York as a corporate consultant in the mid-1950s and remained in that role thereafter, serving as an adviser to departments seeking to develop new businesses and as a corporate evaluator of these opportunities. After retirement Art moved to Cooperstown, N.Y., where he lived until 1990. He was active in civic and volunteer activities and was honored for volunteer service to Basset Hospital—a typical trait of MIT alumni. We send our condolences to his widow, Catherine, and their family.—**Joseph C. Burley**, secretary, 1 Harbourside Dr., Delray Beach, FL 33483; **Lawrence B. Grew**, assistant secretary, 21 Yowago Ave., Branford, CT 96405

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Our class news this issue is limited to one death, that of **Edward Rufus Stevens** on June 9, 1994, at Trenton, N.J. Steve spent his lifetime work in the field of insulation, both hot and cold, in which he received international honors.

Please note the change of address of your secretary. It is the same place back in the woods of Maine a mile-and-a-half from the highway, but a road rather than a P.O. designation.—**Ernest H. Knight**, secretary and president, 168 Ai Plummer Rd., Raymond, ME 04071

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In academic year 1993–94, Dorothy (Mrs. **John**) **Wilson** accepted an invitation to become a member of the Council for the Arts at MIT. Members are appointed to three-year terms. The council is a volunteer group of alumni/ae, spouses, and friends established in 1972 to support the visual, literary, and performing arts at MIT. Throughout the council's history, its members have recognized that creativity lies at the core of MIT's identity, whether in the fields of civil engineering and physics or in disciplines such as architecture and music. Their efforts affirm the Institute's commitment to the arts as an integral part of an MIT education. Recent projects made possible with council support include a student-organized poetry reading series by nationally-recognized poets, the world premiere of *Mozart and Cosmology*, a multimedia performance inspired by the music of Mozart and cosmological theory, and a performance of Bach's *St. Matthew Passion*. Members of the council have been responsible, in large part, for the development of MIT's permanent collection of painting and sculpture and student loan collections of works on paper and photography. Current council members include New York State Council on the Arts Chairman Kitty Carlisle Hart, architect I.M. Pei, '40, art historian Agnes Mongan, and arts patrons Leo Beranek, Vera List, and Raymond Nasher.

There are two deaths to report. **Arnold Ewan** died June 1, 1994, in Germany. We have no further details at this time. . . . **Willard Slagle**, of Plymouth, Mass., died August 13, 1994. Slagle followed his father into the restaurant business in 1936, after a brief career in the chemical industry. He held several chemical and engineering patents. In 1928 he left MIT for a year to travel to Holland with the U.S. Olympic track team, and in 1941 the Army enlisted him to command the Chemical Warfare Service Development Lab at MIT. The Army announced in 1945 that "every American soldier in every theater of action carries equipment made possible by the work of this laborabory." Slagle left the Army as a lieutenant colonel and was awarded the Legion of Merit. He was best known as the owner of Slagle's Restaurant in Boston's financial district. When the restaurant closed in 1986, a *Boston Globe* editorial lamented the loss of a city institution. Slagle was a member of the *National Restaurant Magazine*'s Hall of Fame. He was known nationally as an innovator in the restaurant business. In 1951, The *Restaurant News* said he had "caused eyebrow lifting on a national scale with the introduction of revolutionary methods of food servicing." He leaves his wife, Ellen, two daughters, a son, nine grandchildren, and two great-grandchildren.

Please send news for this column to: Class Notes Editor, *Technology Review*, MIT, W59, 201 Vassar St., Cambridge, MA 02139.

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65th Reunion

Last June **Jack Latham** had "a delightful vacation sailing off the Maine coast." He chartered a 42-foot Hinkley yacht at Bass Harbor and, with his daughter Harriet and her sons as crew, sailed "around the innumerable islands in that area. For the most part they were favored by nice, clear days, but had to navigate in pea-soup fog a couple of times." Harriet saw to it that they had wonderful food. "Every evening they broiled steak or fish over a charcoal grill mounted on the stern rail." For the past several years Harriet has been working on the development of vaccines and is currently testing some of them on monkeys. She hopes to develop something that will have an impact on AIDS. Haemonetics, the company that Jack founded several years ago that makes blood-processing equipment, is still flourishing. It has more than 1,000 employees and its stock is now listed on the New York Exchange. Jack was recently named an honorary member of the American Society of Mechanical Engineers and made a trip to Chicago to receive the citation.

Last spring Anne and **Dave Houston** went on a "Renaissance" cruise from London to Scotland and the Shetland Islands, then on to Copenhagen and Stockholm. They traveled with a group of 44 "great people" that Anne had assembled through her travel agency. Dave still plays golf but, like many of his classmates, has discovered that his game does not improve with age. . . . **W.E. (Cul) Cullinan** reports from Cape Elizabeth, Maine, that there has been no change in his situation—he is "just older!". . . Supplementing the item about **Les Steffens** in the October Notes, it appears that last summer while vacationing in Yosemite with his "San Francisco daughter" he experienced some "chest symptoms" that proved to be what he refers to as a "minor heart attack," but which required triple bypass surgery. He reports that he "survived the hospital food and hopes to get back to low-level tennis next spring."

We have at hand notices concerning the deaths of three more of our classmates: **George Sutton** on January 3, 1994; **Dwight Horton** on March 8; and **Frank Hankins** on August 8.

Unfortunately I do not have anything at all about Sutton in my files. He apparently was living in Charlton, Mass., at the time of his death and is survived by his wife, Ethel. . . . Dwight Horton lived in New Braunfels, Tex., and owned and operated a ranch there for many years. He also did some professional engineering work, primarily in the field of sanitary engineering. He was a charter member of the Texas Registered Professional Engineers and in the 1970s was county engineer of Comal County. He was a life member of Blanco Masonic Lodge and Hella Temple Shrine in Dallas. He is survived by his wife, Helen; a

daughter, Henrie "Beth" Mertz of Austin; three grandchildren; and two great-grandchildren. . . . As previously reported in the Notes, Frank Hankins' career was seriously circumscribed when he became a victim of Parkinson's disease about 30 years ago. After graduating from MIT he worked for PanAm for about 15 years as a pilot and later in an administrative job. Thereafter he moved to Curtiss Wright, where he was an executive engineer and later the service vice-president. After that he worked for Lockheed Air Service before retiring in 1967 because of his disability. The Hankinses lived for many years in Franklin Lakes, N.J., where Frank served as councilman and also as mayor. For a number of years the they maintained homes in both New Jersey and Ft. Pierce, Fla., but eventually became year-round residents of Ft. Pierce, where they were living when Frank died. He is survived by his wife, Anne, who in recent years has typed the reports he sent me, and by their three children. Daughter Anne Bing lives in Old Lyme, Conn., where she is park commissioner. She has also run in the Boston marathon a number of times, most recently in last year's race. She has four daughters. Son Timothy graduated from Dartmouth and then obtained a PhD at UC/San Diego in radio astronomy. He is a professor of radio astronomy at the University of New Mexico and has two sons. Son Frank graduated from Dartmouth and was a Navy pilot for a number of years. He is currently a Northwest Airlines captain and has two sons.

In reviewing my file material on Frank, I ran across a rather fascinating factoid: about 25 years ago Frank spent an interesting evening in Bangkok with our Thai classmate, **Perm Limpisvasti**, who was then air marshall and who looked many years younger than his chronological age.—**Gordon K. Lister**, secretary, Apt. 40, 5707 Williamsburg Landing Dr., Williamsburg, VA 23185

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Please send news for this column to:
Wyman P. Boynton, secretary
668 Middle St.
Portsmouth, NH 03801

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This summer Ruth and I celebrated our 25th wedding anniversary. (I like to call it my longest run) with a trip to Alaska via plane, train, and ship. It was an experience unlike any other—helicopter rides to the top of glaciers, boat rides to village inlets, conversations with people who like the Alaskan winters (not for me) and such beautiful mountainous scenery as to make Vancouver seem anti-climatic. Then this year, Ruth and I had six family weddings!

Arthur Marshall has asked us to find a replacement for him, as class treasurer. It is with reluctance and regret that he submits his resignation for personal reasons. Arthur, we will miss you but we hope you will be active in our future class affairs.

Edmund F. McLaughlin reports that our class is considered to have 180 active members today, with 97 contributing to our MIT Alumni/ae Fund. The Alumni/ae Fund raised $23 million from all classes in the year ending June 30, 1994.

We must report with regret that **Robert K. Mueller** died after a brief illness in August 1994. He was a resident of Newton for many years and a summer resident of Paradox Lake in New York since 1925. After several years in private industry as an aeronautical engineer, Mueller returned to MIT as a professor of aeronautical and aerospace engineering, where he also did research at the Charles Stark Draper Laboratory Inc. After retiring in 1980, Mueller moved to Schroon Lake. He was the summer organist at the Schroon Lake Community Church. He is survived by his wife, Dora, three step-daughters, and nine grandchildren.—**Melvin Castleman**, secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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Werner O. Bachli has been appointed to be our class treasurer by our president, **Wilber B. Huston**. Seems that Werner and Wilber should be able to mete out our funds judiciously. Werner was shocked to hear that **Charles Britton** passed away July 6, 1994, as everyone saw Charles at the 60th Reunion said he looked quite physically fit. Werner is an avowed backpacking hiker and mountaineer, along with his wife, Jeannette. This last Labor Day weekend they spent in the Adirondacks.

Hugh D. McClellan, who was with us in Course IV in our formative years as architects, informs us that he still works as a consultant to the Stamford (Conn.) Community Development program in the rehabbing of older apartments and developing new ones designed to house moderate income families. As I remember, Hugh always seemed to be a step ahead of the rest of us—early on he was in Europe working with LeCorbusier in Paris and with Libra in Prague. Hugh, if you're listening, we'd like to hear of your personal life as well.

Now, if you will turn to the Nov/Dec 1993 issue of the *Review*, you will see the smile of **Benjamin Liberfarb**'s face modeling our now famous sky-high 60th Reunion baseball caps. Whenever I observed Ben at that reunion, he had that same smile. To this day, I recall his being first on the dance floor of our evening get-together. He had the pick of whomever he chose for a dance partner much to the delight of the female contingent there and those of us who were very taken by his obvious delight of the moment. Mrs. Lillian Stern, Ben's sister, informed us of the sad news that Ben passed on June 13, 1994. Ben received an SB in physics, along with **V. Lawrence Parsegian**. He later obtained a Master of Education degree from Boston's State Teachers College and went into the education field while writing scientific papers. He was honored in 1957 when he won a Westinghouse Fellowship for Science Teachers at MIT. Ben had by then served in the U.S. Air Force in World War II, serving in all major campaigns. To my knowledge, Ben remained single. His survivors include two brothers, his sister, Lillian, and many nieces and nephews. I know of Ben's early life in Roxbury, that he went to Boston's English High School before advancing to MIT, since I also lived in Roxbury at the time. I know there will be many remembrances of him as the friendly, genuine person he was at our 60th Reunion. We'll miss him.—**Berj Tashjian**, secretary, 1245 Briarwood Lane, Northbrook, IL 60062-4556, (708) 272-8683

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Al Mowatt, secretary of the Class of '35, forwarded a letter from Hal Everett, '35, who was a close personal friend of Father **Joe Hahn**; they were both transferees into MIT in 1932. Hal reports that Joe died last October. Joe loved jazz and played the piano in a group known as the *Technocrats*, of which Hal was a member. Hal writes, "Joe graduated before me and I lost track of him for a while. Eventually he wrote that he was working for Goodyear's lighter-than-air division in Akron. Then just before Christmas 1944, Father Joe visited me. He had been ordained a Maryknoll mission priest and had been assigned to their mission in Chile, where he rode horseback through the jungle. After Chile, Fr. Joe was sent to China. When the Chang Kai Chek era in China ended, he, like so many other Christians, was expelled from the Mainland by the Communists. Returning to Maryknoll, N.Y., headquarters, he established a sophisticated computer facility, was named publisher of the Maryknoll Order Books, became a duplicate bridge master, and continued his long-standing photographic skills. He was a very modest priest, and I honor him for his humility as well as for the sacrificial foreign mission years and subsequent extraordinary achievements." Thank you, Hal, for a beautiful letter in his memory.

Bea Krim, wife of **Norm Krim**, died in February after a long illness. Bea was a faithful attendee along with Norm at all local MIT functions as well as all our reunions and mini-reunions. She loved gardens and flowers, and Norm arranged a beautiful memorial service for her in May at the Biblical Garden that she had helped create at Temple Israel in Boston. Recently, Norm's sister cajoled him into accompanying her and her husband to a gathering of military lawyers and their guests at a castle in Baden, Austria. It was attended by over 300 military lawyers and 200 guests from 45 countries and 5 continents. They were entertained for a week by the Department of Defense of Austria with many of the activities in nearby Vienna. On the way home, they took the hydroplane down the Danube to Budapest and did the sights. Norm reports that he came home four pounds heavier from all the schloss (whipped cream), strudel, wiener schnitzel, goulash, and beer!

Were you aware that our esteemed treasurer, **Larry Stein**, is an eclipse chaser? In 1991, he and Geri went to Hawaii to see what was purported to be the granddaddy of all eclipses. Unfortunately, the cloud cover was so heavy that they saw virtually nothing. With another eclipse scheduled for this spring in the Mediterranean area, he and Geri, ever optimistic, set off to see it. Unfortunately, they were still in Spain on May 10 when the major activity was taking place in Morocco. But they did see the tail end of a partial eclipse. While their eclipse chasing was not all that great, their trip was! They toured Spain, Morocco, Gibraltar, and Portugal. They had a superb guide who gave them frequent and complete lectures during their bus rides covering the history, religion, geography, economics, and philosophy of the areas they visited. They spent three days in Madrid at the Hotel Wellington, saw the Prado Museum, an overnight in Cordoba, and then on to Granada, where they saw the Alhambra, a beautiful example of the Islamic influence. They went on to Torremolinos (Costa del Sol), with a side trip to a tiny town, Milas, on a nearby mountain. Larry went for a swim in the Mediterranean to the amazement of his fellow travelers. He reports that it was no colder than Nantasket in July! Next was a crossing of the Strait from Algeciras to Ceuta, on to Rabat and Morocco. After a tour of Casablanca, they moved on to Marrakech, which they found the most interesting of their trip. Home on the 25th of May, just in time to rest up for the 60th Reunion.

Paul Wing is cutting quite a swath in the 3-D photographic field. Paul and his wife, Clare, traveled to Colorado Springs this past September to the annual meeting of the Photographic Society of America. Paul is a Fellow of that group and while there received the Stuyvesant Peabody Award for contributing the most to pictorial photography this year. To give you an idea of the prestige of this award, it was given to Ansel Adams in 1961! Paul has been a 3-D enthusiast since his boyhood. He is a charter member and past board member of the National Stereoscopic Association, as well as a charter member and past president of the International Stereoscopic Union. He has a box full of ribbons gathered in competitions worldwide. His collection of stereoscopes, primarily 19th century, is substantial, and the basis for a book he is writing. His professional career started in Chicago working for the Universal Oil Products Co. His interest in the control of these large complex thermal cracking units for making motor fuels led to the job of writing equipment specifications for refineries worldwide. Many of the European units later

ClassNotes

became bombing targets during World War II. In 1941, he and Clare came back to their roots in Massachusetts to work for a small company, Masoneilan, a specialist in automatic control valves used in continuous process control work, together with some pneumatic instrumentation. He enjoyed 38 years of responsible engineering work there, retiring as VP for Engineering at what had become the second largest company in its field. Paul says there is a lot of activity in 3-D these days, even a disposable camera! It is a neglected art form and he continues to promote it. Presently, Paul is working on 35mm projection copies of rare Civil War stereo views by Brady and others to be arranged as a special show next June in Atlanta for the tenth ISU Congress. It was a great change of pace during his career and continues as a major leisure activity in his retirement along with a fondness, as some of us well know, for playing the recorder at class reunions, restaurants, bars, hotel lobbies, or even legitimately years ago with other early music enthusiasts.

At the Alumni/ae Leadership Conference held in September, **John Hrones, Russ Hastings, Al D'Arcey, Tom Burton, Hank Backenstoss,** and **Carl Wilson** had lunch together. The principal subject was how to get more classmates mentioned in each issue of *Technology Review*. Some thoughts mentioned were: biographical sketches, networking of classmates, and reporting back to the secretary. Mini-reunions were suggested, and it was felt that there might be a possibility of doing one in Florida. We would also consider doing one in the Boston area, if there is enough interest. A golf match conducted through the columns of the *Review* was also suggested to determine the class champion. We would work out the details if there is interest. It was suggested that hobbies, vacation trips, second careers, anecdotes involving yourself and/or other class members, even going back to our undergraduate days, would be of interest. We would also welcome news of class widows. Several of the attendees promised to send in stories about some of their own experiences. We would appreciate hearing from anyone who has any thoughts on the above or any other ideas. Remember, your friends want to hear about you!—**Carl H. Wilson,** secretary, 48 Druid Hill Rd., Newton Highlands, MA 02161

35 60th Reunion

Colonel **Louis W. Pflanz, Jr.,** writes from his home in Sierra Vista, Ariz. "At long last the rains came. We hadn't had a drop since last January, not even morning dew. Our temperatures hovered around 100 degrees and humidity got as low as 6 percent." The result was parched woodlands and forest fires. From his living room he watched flames jump from tree to tree on a nearby mountain. Bud said the lack of water and the fires drove the wildlife down into populated areas resulting in several mountain lion attacks. He adds, "I, like others in our class, am hanging in there—though sometimes I wonder why: each morning I wake up to another ache and pain I never knew I had." In November 1993 Bud developed a bad case of hypoglycemia, necessitating an emergency trip to the hospital, but he's now fully recovered. He has plenty of activity chasing his new 2-year-old golden retriever, who likes to jump 3-foot fences and drag his leash through the neighborhood. Bud is still building dollhouses and furniture, which he gives to needy little girls. He is also into needlepoint long-stitch "pictures" and is running out of wall space to hang them.

Bernard S. Freiberg writes from Doylestown, Pa., that he was glad to discover he is one of 228 class members (now reduced from 239). He says, "I don't think I've ever had such an exclusive status, but I can ignore anything except threats." He claims that he is a law-abiding citizen on good terms with the Bucks County DA and most of the judges. He says he *might* still be in good-enough condition to row a few strokes on the class crew next year "if I'm invited to. At least I can still make the weight for the lightweights."

Harold (Hal) Everett writes from a Cape Cod vacation cottage at Ocean Edge Resort in Brewster on his 81st birthday. His wife, Florence, was treating him to a special lunch at Chillingworth's. In September 1932, Hal transferred to MIT after two years at Bowdoin College. He ran into Joseph Augustus Hahn, who transferred to MIT at the same time after three years at Villanova. The two became fast friends and organized a band called the Technocrats. Hal played the clarinet and Joe, who loved jazz, played the piano. They added a drummer, practiced at Hal's family home in Wellesley, Mass., and played for their own entertainment. Joe's story is in the '34 class notes, the class with which he graduated. Hal hopes to see **John Taplin, Earle Megathlin, Gregg Fry, Jack Hossfeld, Don Gittens,** and "all the rest" at our 60th coming up in June.

John Taplin writes from his home in West Newton, Mass., that he recently visited Provost Mark Wrighton in his office. John and his wife, Jinny, would like to enlarge the level of research projects entered into as "collaborative Health Sciences and Technology Projects" between MIT and Harvard Medical School in the HST Program. John says there are several different ways being considered to strengthen the program. He will keep us informed as soon as MIT has a program that will meet the goals of MIT and Harvard Medical School.

The year-end report of Class action on the Class giving for the Alumni/ae Fund lists the Class of 1935 as having the greatest participation of active alumni/ae, at 63 percent. John Taplin's mid-year call for extra giving kept us 4 percent above 1936, 5 percent above 1933, and 6 percent above 1939 (celebrating their 55th reunion). Nice going!

Edward I. Friedman reported the death of Dr. **Ralph B. Woolf** on February 2, 1994. He graduated in Course VII and had a distinguished career as professor of ob/gyn at Washington University, St. Louis. He later was associated with Mt. Sinai School of Medicine in New York and Case Western Reserve at Cleveland. He is survived by his wife, Esther Wexler, two daughters, and two granddaughters. . . . I regret to report the death of **Joseph S. Oldham,** Course X, on March 20, 1994, in his home in Central Falls, R.I. He served in the Army in World War II. He retired in 1975 after working 37 years in the U.S. Postal Service. He is survived by his wife, Elizabeth Ramig, a daughter, a son, five grandchildren, and nine great-grandchildren. I am sending our condolences to the surviving members of the two families.

Keep the news coming—in particular your plans to join us for our 60th Reunion in June.—**Allan Q. Mowatt,** secretary, 715 N. Broadway, #257, Escondido, CA 92025, (619) 432-6446

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A sequel to the McCormick Hall item (October issue) which may interest classmates and other students who bunked anywhere along Memorial Drive. (Other members such as **Mal Blanchard** and **Bill Prichard** commuted from home, or lived in the dorms or apartments. I was in Ware one term, and had two live-in jobs in Boston at other times.)

Over the postwar years the Institute bought on both sides of Mass. Avenue as Memorial Drive properties became available, including most of the "six-pack" brick rowhouses and a large residence at the Endicott Street corner facing Phi Beta Epsilon. Then came Mrs. McCormick's offer of a women's dormitory on campus, and the 314 area was a natural—150 yards from the 77 Mass. Avenue entrance. Tech and the TDX House Corporation, headed by Lindsay Russell, '50, and Ben Beede, '35, agreed to exchange the Endicott corner property for "314" and a substantial mortgage. This enabled completion of the Hall's second (east) wing, and moved the Theta Delts to adequate quarters. A fourth floor was added later. *Footnote:* **Alice Hunter (Kimball)** was Mal Blanchard's date at a 314 house dance in the Fall of 1932. We met, but I think my dancing ability was not very impressive. **Jim O'Neil** and I took a few tango lessons later, but he was smooth without them.

Small one-half world department: A letter from old Santa Fe friends who moved to Australia recommended good-read books, including a 1980 publication *Conductors—The New Generation* by a Philip Hart. This is **Philip Hart, Jr.,** our classmate for two years in chemistry before transferring to Reed College in Oregon and the arts (July 1988 Notes). The book was published here and in London, perhaps the source for Down Under. Retired from managing symphony, Juilliard, etc., but still writing, Phil's biography of conductor Fritz Reiner has just been published. "I celebrated my 80th birthday by falling and cracking three ribs, but am in good health," he says.

Janet and **Bob Gillette**'s son Ned and wife Susan completed some 4,000 miles of camel travel in eight months on the Marco Polo route, from Xian, China to Istanbul. However, they had to abandon the animals at Baku, Azerbaijan, and fly the remainder due to unrest with Georgia. They are now (September) mountain climbing in the Himalayas.

Results from the first mailing to no-show (in these Notes) classmates are encouraging—several replies immediately and more coming. The mailings will proceed somewhat randomly, not alphabetically, through 1995. . . . **Chilton Crane** writes: "Even though my mother's father, John Runkle, was president of MIT

(1870–78, following William Barton Rogers), I went there for only one year (after Yale) to take math and science courses I needed to get into Harvard Medical School." Dr. Crane practiced surgery at Brigham and became chief of surgery at West Roxbury V.A. Hospital. He was president of the Massachusetts chapter of the American College of Surgeons. Since retiring in 1987 he has been writing novels. . . . **William Budd** was Course XIII and made his career in marine engineering at Bethlehem Steel in Quincy, where he was assistant chief engineer—technical, and at De Laval Turbine in Trenton, N.J. He was project manager of machinery design for the first nuclear powered cruiser, the USS *Long Beach*. Bill and wife Velma have been motor-home travelers, square dancers, golfers, and sailors.

Cheers for the lives of **George Robinson** and **Louis Stahl**! A letter from **Dick Denton** tells of George's death July 22, 1994. They both grew up in Wakefield, Mass., commuted to MIT together, and did their MS thesis jointly in Course XIV. George was a member of the Institute Committee, conductor of the MIT orchestra, and president of the 5:15 Club. Such activity continued into adult life in Clark Township, N.J., where he was "Mr. Everything" to the community for 40 years (Feb/Mar '90 Notes). His career in chemical engineering culminated at Union Carbide in Bound Brook, where he was assistant director of engineering and project manager. After retiring in 1972 he served as town administrator for 18 years. His widow, Virginia, reports that he was not seriously ill until June, but became afflicted with Alzheimer's disease around the time of my 1989 visit.

A *Boston Globe* article tells of **Lou Stahl**'s death August 29. He served the Institute and our Class nobly: as member of the Corporate Development Committee and fund raiser, and as our 50th Reunion Gift Chairman. His Bronze Beaver citation paid tribute to these and "long intense personal support of MIT." Lou started with his father's company making chemicals to treat and color leathers, and expanded the business into a dozen countries—one of the first from America in China. He founded Polyvinyl Chemicals, also international, which invented pour-on floors and erasable ink, and later sold both companies to Beatrice Foods. Lou took on the presidency of its chemicals division, and helped the company to diversify here and abroad. He and Dorothy, his loving wife of 54 years (January '93 Notes), raised two children, Leslie and Jeffrey. Their success has given Lou and "Dolly" great pleasure.—**Frank L. Phillips**, secretary, 1105 Calle Catalina, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson**, assistant secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Donald S. Duncan's wife, Jean, writes a rather sad note. "Unfortunately, Don is now in a nursing home, a victim of Alzheimer's and of a stroke several years ago. He's been in the home since April 13, 1994, and is reasonably content. My adjustment isn't as good as his! If anyone wants to send him a cheery card, his address is Bennington Health & Rehab. Center, 360 Dewey St., Bennington, VT 05201. I think he would enjoy being remembered.". . . **Joseph Haywood** retired from American Sterilizer as design engineer. He is now adjunct professor (mechanical engineering) at Gannon University in Erie, Pa., and has completed "Principles of Static Mechanics" and is looking for a publisher. Perhaps MIT Press? His work in progress is a translation of Lagrange's *Mechanique Analytique*.

E. Putnam Head retired in 1979 as regional manager of Mason-Neilson Reg. Co. He celebrated his 80th birthday on July 26, 1994. He enjoys playing the banjo and doing word search and crossword puzzles. He's lived in Atlanta since 1940, when his Boston employer moved him down there from Buffalo. Every summer he and his wife, Skip, go to North Falmouth, Mass., where he was born. One of their sons lives there in the house that belonged to Putnam's father. Their other son and his family live in Raleigh, N.C., where he is executive director of the North Carolina Bar Association.

News from **Ernest Ferris**—"I've been retired for 11 years from the Borg-Warner Corp. and have done very little clutch engineering since then. I've been living in the same house for about 35 years and only now am thinking of moving because my three sons are scattered from Pennsylvania to Oregon. For exercise I golf a bit, work around the yard, and in fall and winter I bowl and look for someone to play racquet ball. The rest of the time is spent visiting the grandchildren, reading, and listening to the awful news of the world. From our class I've been in touch with **Bill Bakarian, Ray McFee, Bob Brauer**, and **Mike Zinchuk**, but the notes are getting smaller and fewer."

Received word of the death of **James B. Henderson, Sr.**, on June 18, 1994. He was 80 years old, a retired branch chief in the compliance division of the Nuclear Regulatory Commission, and a lay reader of St. Paul's United Methodist church in Kensington, Md. A resident of Wheaton, Md., he was born in Agawam, Mass. During World War II, he worked in the shipbuilding industry on the West Coast. In 1946 he went to work for the Southern California Edison Co. and was project engineer for the development of the San Onofre Nuclear Generating Facility. In 1968 he moved to the Washington, D.C., area and joined the compliance division of what was then called the Atomic Energy Commission. He retired from the NRC in 1988. Survivors are his wife of 54 years, Ruth Miles Henderson, two children, and three grandchildren.

The following obituary appeared in *The Oregonian* (Portland). **Lillian M. "Polly" Povey Thompson**, "a prominent Oregon architect who supported the advancement of women in her profession, died of a stroke June 26, 1994, in a Portland hospital. She was 89. Her early appreciation of art was nurtured while working during her youth at her father's stained-glass studio. That led her to earn a bachelor of arts with honors in architecture from the University of Oregon. While at the university, she also met, and later married in 1929, a fellow architectural student, Raymond Kermit Thompson. She went on to earn a bachelor of architecture at MIT. Following World War II, she and her husband and two children returned to the Portland area and started the architectural firm of Thompson & Thompson, AIA, Architects. She was an active partner in the firm until her death. Mrs. Thompson designed stained-glass windows for

a number of churches, and her husband co-designed. She also wrote articles and gave lectures on the subject of stained-glass. Mrs. Thompson was recently featured in an exhibit, 'Matriarchs—Pioneering Women of Architecture,' sponsored by the Portland Chapter of the American Institute of Architects. She is survived by her husband, a son, and a daughter." Our deepest sympathy go to the Henderson and Thompson families.—**Robert H. Thorson,** secretary, 66 Swan Rd., Winchester, MA 01890; **Leonard A. Seder,** assistant secretary, 1010 Waltham St., #34B, Lexington, MA 02173

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We now have further information about **Walter F. Kaufman** who died in April and whose wife, Ruth, died quite suddenly in September 1993. C. Arthur Zeldin, '39, gave us the address of one of their daughters, Mrs. Margaret Markle of Northumberland, Pa. From her we learned that Walter's other daughter, Mrs. Elizabeth Mabus, still lives in Sunbury, Pa., where Walter worked for many years with Paulsen-Webber Wire Rope Co., now known as Paulsen Wire Rope Co. Walter suffered a severe stroke in 1975, but with hard work and the devoted assistance of Ruth, he made a remarkable recovery and continued work as plant manager until he retired in 1982. For the last six years he lived in Sarasota, Fla. During retirement he organized and was a charter member of the American Society of Senior Wire Rope Executives, who held annual meetings at various resort areas.

Robert L. Johnson died in early September in Hanover, N.H. He and his wife, Patricia, lived in Sarasota, Fla., and Quechee, Vt. After serving in the Army during World War II, he joined Arkwright Insurance Co. in Boston, where he rose to chairman and CEO in 1972 and held these jobs until his retirement in 1981. A longtime Wellesley resident, he was a director of the Fidelity Funds and New England Merchants Bank and a member of the Economic and Commercial Club of Boston. As a golfer, he was a member of country clubs in Massachusetts, Vermont, and Florida.

Class President **Fred Kolb** shares with us his genealogical pursuits and his month in France in July: "Polly and I started searching for our roots many years ago. We actually searched several European communities during vacation travels. After we discovered the Family History Library and the Branch Library right here in Rochester, we made a lot more progress. Finding microfilm that reproduced the parish registers for tiny communities in Germany and Sweden was much more constructive than jumping on a plane. This spring, as an adjunct to an Elderhostel program, I found the marriage certificate for one set of grandparents; and I tracked down the wanderings of a great-grandparent through Pennsylvania and into Ohio.

"The trip to France was on another totally different key. We have spent many vacations in France, and before retiring I had some liaison responsibilities with Kodak-Pathe Research. Thus I have a group of very close friends there, and getting to see them unleashes a flood of memories and discussions. Pacing this year's trip was another Elderhostel program, a two-week bicycle tour of the Loire Valley coming in the middle of my trip. The advantage of Elderhostel is that the minimum ago of 60 means it was not intended to be a competitive sport!

"It was a quality tour with a group of 22 participants—travel on small roads nearly free of traffic, a van carrying our luggage, overnights in family hotels with showers and restaurants. There were some expert bicyclists in the group, but I was pleased to evaluate my performance as only a little below the median. We averaged about 30 miles a day, and there was time each day to visit the neighboring medieval city or chateau. We had previously seen many of these places while touring by car; they are very different when toured by bicycle!

"Upon first arriving in France, I spent several days in Montpelier as a guest in a family I've known for 40 years. We first met when their daughter was two weeks old. When she became a teenager, she had a summer job in Rochester and lived with our family for a month. This year she came with her husband and children to visit her parents the day before I left.

"My last week was in Paris visiting with friends and shouldering my way through unbelievably dense crowds of tourists. Fortunately, I know the city well enough to spend most of the time away from the tourist traps. Remember the key presentation at Technology Day this June, with I.M. Pei talking to us about his plans and procedures in remodeling and expanding the Louvre? It was clear he succeeded by combining diplomacy with his architectural expertise. Especially helpful was the cooperative relationship he developed with President Mitterand of France. I spent a day checking out some of the highlights he had shared with us, and the results are impressive. By itself, the Louvre's new look is well worth a trip to Paris. If you go, enter by 9 a.m. when it opens, since it resembles a cattle stampede by the end of the day."—**Paul R. Des Jardins,** secretary, 6241 Old Dominion Dr., Apt. 310, McLean, VA 22101-4807, (703) 534-4813; **Gretchen Birge,** assistant secretary, 233 Carroll St., Apt. 202, Sunnyvale, CA 94086-6264, (408) 736-5011; **Frederick J. Kolb, Jr.,** president, 211 Oakridge Dr., Rochester, NY 14617-2511, (716) 342-3093

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Dominic Donatello and Jean are Horatio Alger role models for their family and neighbors in Alaska. In World War II, Dom enlisted as a private, served in aircraft maintenance in the Aleutians, and was honorably separated as a major. He recognized a need in Anchorage for household bleach, made a batch in a vinyl-coated 55-gallon drum, and sold his product. After 45 years of responding to other needs of Alaskans, Dom's expanded enterprises produced $11 million of gross revenues in 1992. His companies manufacture floor waxes and process bones and meat scraps to make tallow, soap, meat meal, and fertilizers. He also warehouses and distributes industrial chemicals and has bought and sold a fleet of railroad freight cars. His sound business practices and vigilant attention to details earned compliments and commendations from Alaska business magazines; the Department of Natural Resources of the State of Alaska; Ted Stevens, U.S. senator from Alaska; Walter J. Hickel, governor; and

from former President Lyndon Johnson. Still, on a typical day, Dom opens the business at 6 a.m. and closes at 6 p.m.

Bob Touzalin and Aletta completed the 600th mile (of England's 2,000 miles of navigable canals) in a leased canal boat about 7 feet wide by 40 feet long. During each of 15 prior summers they toured about two months in such canal boats neatly equipped with standard amenities. As they boated in England and four countries of Europe, duties were naturally divided so that Bob did the piloting and navigating. Aletta preferred to work the locks, some of which are hand-operated. Bob timed daily schedules so that the pause for lunch and anchoring for the night alongside the canals took full advantage of excellent meals served at nearby pubs. After returning to the United States this year, they drove to visit **Fred Cooke** and Eugenia in California and Hilda and me in Tacoma, Wash. From here they planned to visit **Bob Schmucker** and Jean in Amherst, N.H., and then return home to enjoy autumn golfing in Naples, Fla.

In the new Seattle Aerospace Museum, **John Alexander** and I attended a lecture about the Earth's first man-propelled sustained flight in the Gossamer Albatross #1. Then we viewed a retired SR-71 supersonic jet plane, one of which set a world record by flying at 2,200-plus miles per hour at 80,000-plus feet elevation from Los Angeles to Washington, D.C., in one hour and eight minutes. (**Ben Badenoch** had a hand in designing its landing gear.) That record was set 22 years ago by U.S. designers, aircraft builders, and U.S. military. No other country has equaled or exceeded it. John and Nancy will join Hilda and me to listen to about 15 choruses and 23 quartets, all specialists in barbershop harmony, as they perform to determine the champions. The Evergreen District includes SPEBSQSA members from two Canadian provinces and four northwest states.

John Donovan and Janice retired to Boulder, Colo., where, at 7,000 feet elevation, they live about as close to heaven as some people get in their lifetimes. During his career solving chemical-associated problems, Joe developed fireproofing treatments for textiles. He says the military liked the products and could pay, but caring mothers of new babies were not ready then to accept the texture and cost of fireproofed garments. Janice teaches English. Some months after Joe helped her with a class of Japanese military personnel, they received a specially guided three-week tour of Japan's natural beauty spots. . . . **Jim Barton** is in a rehabilitation hospital that specializes in therapies to benefit muscle systems. . . . **Jean Dana** phoned that the Danas' first-ever trip to the Pacific Northwest had to be deferred because Joe fell while playing tennis.

Gus Hunicke underwent major surgery and lost 20 pounds. He's recovering nicely as he cruises in the Caribbean. Gus said there must be a better way to lose weight than the one he used. . . . **Dick Cella** and Ivana write from New York that their son graduated from Fordham and joined Dick in his famous restaurant on East 46th Street. . . . **Roy Heacock** retired to Sacramento after many years engineering and manufacturing rotary dryers, coolers, and kilns for industry. Roy enjoys the activities of his daughters and their two children, two dogs, and five cats. Roy says the dogs don't chase the cats.

Franklin Bent retired to Delaware after a chemical engineering career in the U.S. and abroad. His expertise in process and cellulose acetate still brings invitations to consult. . . . **Bob Atwater** retired from engineering at Nabisco, lives the quiet life in New Jersey, and enjoys lunches at his Senior Citizens' Club. . . . **Bob Withington** and Betsy reserved passage for a tour of China, and were surprised to learn that **Hans Bebie** and Austie were booked on the same tour.

Earl Reynolds and Betty report one '39er accepted their invitation to receive a copy of *The Tech* newspaper from the 1939 June Week. In communicating about events in our careers, Earl said: "In 1956 I attended an Industrial Sanitation Management Association meeting at Kodak. Three companies that built water fountains attended. Cleaning around floor-mounted units was expensive. I asked each one why he did not build a wall-mounted unit. None showed any interest, but after returning home, all rushed to build them. So, when you use a modern wall-hung unit, remember that ENR started the ball rolling."

Earl relayed a clipping from the *Marblehead Register*: "...**Richard D. Martin**, a retired engineer formerly employed by Polaroid, died July 8, 1994, in Salem, Mass. He served as a meteorologist with the Army Air Corps during World War II. He was active in Marblehead politics and was a past chair of both the Town Finance Committee and the Personnel Board. He was an avid sailor and was a member of the Eastern Yacht Club, where he raced sailboats for many years."—**Hal Seykota**, secretary, 2853 Claremont Dr., Tacoma, WA 98407

ClassNotes

40 55th Reunion

A report from the Alumni/ae Association identifies donations by class. Of the 362 known members of our class, 194, or 54 percent gave a total of $452,973. Of these donors, 63 percent gave $100 or more. That places us among the higher percentages in both categories as compared to other classes. As the mailings should have been received by the time you read this column, I won't include any of the details of the reunion. But Sally (Mrs. **Bob**) **Bittenbender** and **Bill Stern**, co-chairs of the reunion, are doing a fine job of planning and organizing. We can all look forward to a great time!

A letter from **David "Beano" Goodman** describes some of his adventures in recent travels. The saga begins with a one-way flight on the Concorde to London and a return voyage on the *QE2*. The whole thing was a disaster. Due to engine troubles, the Concorde had to fly subsonic, ran low on fuel, and landed at Shannon instead of London. They finished the trip many hours late on a 737. The *QE2* had good rooms but terrible food and service. Two months later, Beano received a letter of apology from British Airways with two $750 vouchers, which could be cashed. He did. As this was only a small part of the package, his travel agent complained and Beano was given a free crossing on the Concorde. On the return trip, however, there was a similar problem to that on the first flight, and they wound up in Halifax for eight hours. His complaint this time produced two $500 checks! Now he is considering offering British Air a promise that he will never fly the Concorde again for a flat payment of $10,000. He thinks that is reasonable!

Here is a continuation of the list of classmates whose whereabouts are unknown. If anyone has knowledge of these people, please send the information to me: **James H. Reid, II, Wilbur L. Roach, Budd R. Robb, Judson M. Rogers, Isabel S. Rowe, Clifford L. Sackett, Charles F. Sargent, Seaton Schroeder, Jr., Frank L. Sheldon, Nathan Sherman, Jesse R. Singleton, Stanley C. Skeiber, Harvey C. Smith,** and **R. Robert Snyder.**

Ivor Collins, '41, reports the death of **Charles S. Smith, Jr.**, on September 4, 1994. He was professor emeritus in the Department of Physics at UNC-Chapel Hill. He received the ScD with our class.

Class President **Norman Klivans** received a note from the widow of **Theodore H. Talbot,** who passed away on May 30, 1994. Mrs. Talbot wrote that her husband treasured his years as a student, and that his interest in the Institute never wavered. He retired from E.I. du Pont de Nemours & Co., where he was a senior patent chemist for 30 years. Thereafter, he moved to Danby, Vt., where he worked for many years as a volunteer maintaining trails, and he was an "end-to-ender," which meant that he had hiked the entire Long Trail from Massachusetts to Canada. He was an avid hiker and skier and was active in the Green Mountain Club, the Appalachian Mountain Club, and the Delaware Valley Chapter of the AMC, of which he was a founder.

John O. Crum of Redlands, Calif., passed away on March 10, 1994. John served in New Guinea for four years during World War II, and later received a master's degree in aeronautical engineering from Caltech. He spent 37 years with TRW as a propulsion development engineer. He helped develop stages of Minuteman I, Minuteman II, Minuteman III, Peacekeeper, and Midgetman International Ballistic Missile Systems, and was responsible for providing the thrust characteristics for all stages of all five missiles.

Another death was that of **Arnie Wight** of Amherst, N.H., who died on August 4, 1994. A tribute to him in the local paper is headed, "Principled Negotiator," and says, "Amherst lost a character last week, a character in the best New England sense of the word. Arnie Wight died after a lifetime of service to his community and his fellow man. He was a familiar figure in Amherst, Arnie with his walrus mustache, and his willingness to stop and talk, any time, any place. He was town moderator for 28 years. After four years as a naval officer and a distinguished business career, he then served his town for ten years in the legislature, where he was chairman of the Science and Technology committee. . . . All of us pay lip service to the importance of ethics and agree that more should be done to encourage ethical conduct. Most of us let it go at that. Not Arnie. He had founded a consulting firm called Principled Negotiations, and he was active with the Institute of Global Ethics, an organization promoting ethical foundations in global affairs. If the world could follow the ideals of Arnie Wight this would be a pretty nice world indeed."

The above was reported in a letter from **James H. Moore**. Jim also writes, "After I retired, Arnie's path and mine crossed when we were both appointed to the Governor's Task Force on High Level Nuclear Waste when the Department of Energy was looking at a potential high level repository site in New Hampshire, among others. I was appointed because of my involvement with geoscience questions, and Arnie because of his legislative and conflict resolution background. We served on that for three years, and then on a legislative advisory committee on nuclear waste. I chaired the committee for a year, and Arnie took over as chair when I retired from it. Arnie became nationally known for his involvement in the conflict resolution process in the energy field, and I know he will be missed very much by those with whom he worked. Just a word about my current status: after many years as summer residents and then for 15 years as full-time residents, we sold our home on Governor's Island in Lake Winnipesaukee and moved to New London, N.H. That meant that I had to resign from the board of the North Country Resource Conservation and Development Area, having moved out of the four county region it serves. I still continue on the board of directors of the New Hampshire Lakes Association, which is statewide. My principle activities with NHLA are helping the staff with computer system operation and database design and maintenance, and serving on the Watershed Protection and Water Quality Committee. Since retiring in 1984, Beverly and I have taken at least one long trip per year, usually to the southwest. This year, it covered 10,000 miles and seven weeks, from South Carolina to the southwest, California, the northwest, and Canadian west and back via the Trans-Canada highway." Jim also tells of his two daughters' involvement with MIT, and of his son, who is a hydrogeologist.

Keep those letters and telephone calls coming.—**Richard E. Gladstone**, secretary, 250 Hammond Pond Parkway, 1205 S, Chestnut Hill, MA 02167-1528, (617) 969-5161

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Nancy Oh, a housemate of **Malcom (Joe) Dodd**'s daughter in Cambridge, informs us that Joe died on August 14, 1994. Joe was mentioned in these columns in October 1992, recounting his attendance at the May 1992 Banquet of the Flight Test Historical Foundation, to commemorate the 50th anniversary of the maiden flight of the first U.S. jet aircraft, the Bell XP-59A. In April 1993, we reported that he had canceled his plans to attend the true anniversary of the event on October 2, 1992, at Edwards Air Force Base, because of a laryngectomy on July 31, 1992. He and Virginia had just celebrated their 50th wedding anniversary in June.

Joe received these invitations as a true pioneer of jet flight. Graduating in Course IX, with a strong interest in aviation at MIT, he was a member of the Aeronautical Engineering Society, the Society of Military Engineers, the Society of Automotive Engineers, and Advanced ROTC Engineers. Entering active duty as an engineer, he transferred to the Army Air Corps and Wright Field. There he was assigned to the Fighter Branch, and shortly to coordinate construction, become officer-in-charge, and assistant project officer (aircraft) of a new secret airfield in the desert at Muroc Dry Lake, Calif. The purpose of this field became clear on October 2, 1942, when the Bell XP-59A jet fighter took to the air. Up to that time, and between later flights, it was duly camouflaged with a fake propeller rigged on its nose. Joe left the service in October 1946 as a major, serving many years as a reserve officer.

Joe was employed at Thermix Corp. in Greenwich, Conn., and Aerotherm (PTC) Aerospace in Bantam, Conn., in engineering, sales, and research and development. He was an active member of St. Michael's Episcopal Church in Litchfield, Conn. In the 1950s he was a lay reader at Christ Church in Bethlehem, Conn., from which he led services at the Southbury Training School. For 10 years he served as Litchfield board of finance chairman, and later, for several years, as selectman. He was a director of the Litchfield Mutual Fire Insurance Co., chairman of the Litchfield Chapter of the American Red Cross, and past president of both the Squantum Club and the Litchfield Country Club. In 1985 he and his wife, established residence in Tucson, Ariz. Besides his wife, Virginia, he leaves two sons, a daughter, and four grandchildren.

MIT has just informed us of the passing of **Robert S. Lundberg.** Our *1941 Technique* records that he was in Course IV, and lived in Belmont, Mass. *MIT Alumni/ae Registers* tell us the following: He joined the Navy in September 1941 and was discharged as a lieu-

tenant commander in December 1945. From 1948 to 1961, he was successively designer, project architect, and associate at Vorhees, Walker, Foley, and Smith, architects and engineers in New York City. In 1975 he was listed as partner at Hayes, Lundberg, and Waehler, also in NYC. His wife then picks up the story, writing, "When Bob received a call at the office for a new building the thought crossed his mind, 'three more years of problems!' He knew then that was the signal to let go. He enjoyed the leisure of being at home for almost 20 years. Certainly it was a good example for me and the three boys." The class expresses its sincere sympathy to the families of both our departed classmates.

Connie Nelson, from Minneapolis, was in town after visiting **Bill Lamar,** at his beach house in North Bethany Beach, Del. Bill was attempting to duplicate a mini-reunion of local Course XVIers (reinforced) held in the fall of 1992. This time fate, misunderstandings, and delayed U.S. Mail conspired to keep the Lamars entertaining separate guests for three weeks—first **Chet Hasert,** then Connie, with **Ed Hayes** and his wife Marie trailing in the third week.

Chet, Connie, and I had lunch in late September. They also recounted that Bill's report—covering 30 years research on the X-29, a research aircraft with swept-forward wings—had finally been completed and sent to Wright Field. This time it was UPS who failed to deliver, and Bill, clutching his useless UPS receipt, was scurrying around, retrieving information from his computer, and assembling appendices from assorted report files. Good luck, Bill!

Chet also reports that **Al Pedraza** had a triple bypass heart operation in Miami Baptist Hospital on July 19, and was doing well in recovery. Al saw Chet's address in *Technology Review* and wrote to him because a friendship had developed between the two freshman section-mates in their daily walks to MIT, across Memorial Bridge from their digs in Boston. This friendship was reinforced in 1961, a low point in Al's career, when he enjoyed Chet's invitation for an impromptu ski weekend. Al, a native Cuban, had just left Havana when Castro took over Goodrich Cubana S.A., where he had been general manager. He later was sales manager for another subsidiary of B.F. Goodrich, Inc., in Bogotá, Colombia, and worked for CCF Cargo Steamship Co. in Miami until retirement in 1980. We all wish Al a continued speedy recovery at a new location in Miami. Since new instructions from MIT discourage publication of alumni/ae addresses, classmates should contact me for his address.—**Charles H. King, Jr.,** secretary, 7509 Sebago Road, Bethesda, MD 20817-4839

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Mort Goulder, while continuing as president of M.E. Goulder Enterprises, has been appointed senior technical advisor of Ferrofluidics Corp. in Nashua, N.H. Sounds very high-tech, and we're certain that Mort will do well. . . . **Irv Fagerson,** a professor emeritus at the University of Massachusetts, died in Boston in June. Irv received a PhD from the University of Massachusetts in 1950. He was a professor of food science there until he retired in 1989. . . . Also, **Gunner Orberg,** who graduated in Course V, passed away in São Paulo, Brazil. Gunner was president of Resana S/A Indust Quimicas. He is survived by his wife, Sonia, and three children.—**Ken Rosett,** secretary, Apartment 12, 2222 Americus Blvd., N., Clearwater, FL 34623

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Please send news for this column to:
Bob Rorschach, secretary
2544 S. Norfolk
Tulsa, OK 74114

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It is with deep regret that we report the death of **Edgar P. Eaton, Jr.,** on July 19, 1994, after a long illness. Ed led a full life of service as soldier, engineer, business executive, alumnus, and family man. From Coast Artillery ROTC, Ed became an anti-aircraft artillery officer during World War II and was wounded. He was awarded the Purple Heart. He graduated in Course II after the war. Later, he earned a master's degree from Boston University.

Ed worked in the New England area at Electric Boat-General Dynamics and at the Boston office of Allis-Chalmers. In 1949, he went to Boonton, N.J., to work for Carbone-North America. He retired in 1990 after 42 years, serving in many positions including president, CEO, and chairman. During his professional career, he received 12 patents and many industry awards. Not content with retirement, Ed qualified as a certified financial planner and became an owner-officer of Brinton-Eaton Associates. In New Jersey, he volunteered and served as trustee and board member of many civic and charity organizations.

But it was with MIT that Ed was unstinting in his time and efforts as booster and fund-raiser. From 1975 until his death, Ed was in many leadership roles for the benefit of MIT. A grateful MIT honored him with the Lobdell (1986), Kane (1989), and Bronze Beaver (1992) awards. Weakened as he was, Ed attended our 50th Reunion in Maine and at Cambridge. He was determined to present our class gift on Tech Day. This he did, with dignity, on June 3, 1994. It was Ed's last official act as class president. Our condolences go to Helen, their two sons, and five grandchildren.

The Alumni/ae Office has just sent us notices, all in Spanish, on the death of **Andrés Antonio Freites,** Course XV. His death was listed in our 50th Reunion book, but the date was not known. Special thanks go to student Jacob from Puerto Rico at the Spanish House for assistance in the translation of these notices.

Andrés worked for Esso Standard in his country, in Cuba, and in the United States. He became its general manager in the Dominican Republic. He then worked for Falconbridge-Dominica and became its president. He was an opponent of the Trujillo regime which caused his exile. After the dictator's overthrow, Andrés became the ambassador to the U.S. in 1961 during the interim government of Rafael Bonnelly. In 1963 he was the foreign minister for President Juan Bosch. In these positions, he negotiated a more favorable sugar quota and secured the release of $22 million in much needed funds. Afterwards, he was a principal in many business ventures, including minerals, to which he was exposed at MIT. He was mostly bedridden during his last few years.

Andrés died of a cerebral tumor on May 14, 1991. The next day, he was buried with full national honors and a 21-gun salute, in the Dominca National Cemetery. Our much belated condolences go to Mrs. Antonia V. Freites, their three children, and their families.

As a courtesy, we reprint this from the '45 Class Notes of the Aug/Sept 1994 *Technology Review*: "Now hear this! There will be an MIT-Navy V-12 reunion in June 1995." For you ex-swabbies who are interested, start reading the '45 Class Notes and contact Clint Springer, '45 secretary, for more information—Co-secretaries: **Louis R. Demarkles,** 77 Circuit Ave., Hyannis, MA 02601; **Frank K. Chin,** 221 St. Paul St., Brookline, MA 02146

45 50th Reunion

Your 50th Reunion is just three months away! Can you believe it?! Why it only seems like yesterday that we graduated in either dress whites or cap and gown. Our 50th will allow us to really see and participate in an all-cap-and-gown ceremony. Detailed registration forms, schedules, etc., will be forwarded within 60 days, but we've included a refresher of our program here.

It had been your Reunion Committee's initial hope that our 50th Reunion Book would be forwarded in March; however, several of us have not forwarded biographical data as promptly as anticipated. If you are one of the delinquents, please forward your data now. The committee also seeks your input as to how the scheduled V-12 Reunion following Technology Day on Friday, June 16, should be formatted and integrated with the Class Reunion. Please forward your thoughts and comments to me or Robert Dimmick at the Alumni/ae Association office.

Friday, June 9, will feature Graduation—Class of '95. Saturday and Sunday, June 10 and 11, will include an unstructured Boston or New England weekend. Monday, June 12, through Thursday, June 15, we'll be at Black Point Inn, Prouts Neck, Maine. On Thursday, June 15, we'll attend President Vest's Reception, a Pre-Pops Dinner, and Tech Night at the Pops. Friday, June 16, is Technology Day and the Navy V-12/1945 Gala Celebration. Saturday, June 17, are the Alumni/ae Challenge Games!

Fran just read these notes and said I should mention our two new granddaughters: Alicia Hennigan Springer, born October 18, 1993, and Francesca McIntyre Schembri, born June 20, 1994. Francesca was named for her grandmother and is the daughter of Dr. Lawrence Schembri, '85.—**Clinton H. Springer,** secretary, Box 288, New Castle, NH 03854

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There's little to offer beyond the relief we had when the hubbub on the Haiti flap was finally called off as I was writing this around September 20. So I'll just tuck in a piece that **Bob Hoffman** sent.

"Attention Class of '46: Here's a preliminary report from your Reunion Committee. Newport, R.I., has been selected as the location for our off-campus 50th Reunion in June 1996. From the standpoint of places to see and things to do, Newport has much to offer. Details will follow. In the meantime we have one small request. If any of you have some good photographs taken at our 5th and/or 10th Reunions, it would be appreciated if you could send (lend) them to **Russ Dostal**, who has volunteered to assemble a collection covering all nine of our previous great reunions! We plan to display these during our on-campus time in the lobby of McCormick Hall, which is traditionally the headquarters for the 50-year class. Send pictures to Russ at 12000 Edgewater Dr., #401, Lakewood, OH 44107.

"Also, we are looking for someone willing to undertake the preparation of a 50th Reunion Souvenir Yearbook. Please contact Bob Hoffman directly at 18 West Lane, Madison, NJ 07040, or phone (201) 377-4650. Working for the committee at this point are **Glen Dorflinger**, president; **Herg Oedel**, treasurer; **Jim Ray**, secretary; **Jim Craig**; Russ Dostal; **John Gunnarson**; **Ted Henning**; **Ted Heuchling**; **Bill Rapoport**; and Bob Hoffman, reunion chair."

Bob and Marion Hoffman traveled to Phoenix last April to attend an Elderhostel (their second). The following week they toured Arizona by car from Tucson to Jerome, to Grand Canyon National Park, then on to Monument Valley, the Petrified Forest, and back to Phoenix. Beautiful scenery. . . . Also newsworthy is Bill Rapoport and wife Freddi just came back from a wonderful trip to Alaska.

Hope you all have a happy Yuletide.—**Jim Ray**, secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Right after the last issue of *Technology Review* hit the streets, my phone rang one morning. It was **Bill Kurtz**—he said that, since we were neighbors, he thought he should call. Bill lives in Castle Rock, about 15 miles from us. He retired from the U.S. Navy as a captain in 1964. He got his undergraduate degree from the Naval Academy and a graduate degree from MIT. While in the Navy, he worked on the Polaris program; afterward he went to Raytheon as Apollo program manager. Then he spent 11 years in marketing with Northrup, based in Washington, D.C. In 1988, he and Betty, his wife of over 50 years, decided to "return to their roots" and moved back to Colorado. They have a son, Bill Jr., and a daughter, Leslie. Bill lives in California and has two children, a 12-year-old son and a 14-year-old daughter. Leslie lives in Aurora, Colo., about 30 miles from Castle Rock. Bill and Betty were headed for Helsinki and other Scandinavian destinations two weeks after we talked.

Dick O'Donnell was kind enough to send us a copy of a letter to Ken Brock, '48. Ken was recently elected chairman of the Cape Cod Planning Commission, and Dick was recently elected chairman of the Hilton Head Island Planning Commission. Dick was drawing parallels between the two jobs and the two areas—both are tourist destinations and retirement communities, and each of these groups has very different agendas. As Dick says, the tourist-oriented developers and Chamber of Commerce want virtually unrestricted growth but the retirees want all building stopped yesterday! Dick has learned the hard way that you can't please everyone and attacks in the press are standard procedure. He has been very active in the community before, however, so he's learned not to let the criticism get to him.

Jim Prigoff brings us up-to-date every so often on his travels. He writes, "The end of May I was invited to lecture in Belfast and Derry following an invitation to Birmingham, England. My subject was murals and spray-can art from around the world. The trip to Northern Ireland, my first, was fascinating. I had the opportunity to photograph a whole genre of political murals that are unusual and to witness firsthand the armed-camp atmosphere of this part of the world. It is intense. Also, I drove the countryside, the coastal areas, walked on the Giant's Causeway, saw the peat bogs, and the eternal green that comes with lots of rain.

"Arline had two conferences to attend in Sri Lanka this summer, so on the way we stopped in Bali, went to see the lizards (dragons) on Kimodo Island (12 feet long and up to 300 pounds), stopped in Yogyakarta to see the great Temples of Borobudur and the Prambana, and took a few days in Singapore. I hadn't been there in 10 years and was amazed to see how it has changed. We had some excellent snorkeling in Bali, at a place called Red Beach near Kimodo and in Sri Lanka at Hikkadewa. Sri Lanka has some very interesting ancient Buddhist sites. At Sigiriya, I found 5th century frescoes painted 300 feet up a 600-foot stone monolith, still in outstanding condition. The top of this huge outcropping was used as a fortress and palace in those days.

"In February I skied Aspen. The main reason I keep at that sport is that at age 70 many areas let you ski free. I'd like to get even with them, if only just a little!"

Attention all MIT Navy V-12ers! There will be an MIT V-12 reunion in June 1995. The Class of 1945 50th Reunion committee will be sponsoring the V-12 reunion as part and parcel of the Class of 1945 cocktail and dinner party following 1995 Technology Day on Friday, June 16. Since the 1995 Technology Day program will be focusing on the 50th anniversary of our victory in World War II and the social and economic impact that this war had on technologies at the Institute, the Class of 1945's sponsorship seems most appropriate. Details of this event will be unveiled in the months ahead and the Class of 1945 reunion committee will attempt to communicate with all V-12 alumni/ae.—**R.E. "Bob" McBride**, secretary, 1511 E. Northcrest Dr., Highlands Ranch, CO 80126

ClassNotes

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Ellarson Stout retired from Perkin Elmer Corp. in 1989. The Hubble Telescope was one of the last projects on which Ellarson worked. He wrote that he is pleased that it has been fixed and is returning such fantastic data. He has time to do all the things he really enjoys. These include skiing, hiking, biking, back packing, travel, and more. Retirement is great! . . . **Boni Philip Martinez** wrote a brief note: "I'm still living!"

Robert Thena died at Leisure Park Health Center in Lakewood, N.J. His first wife died in 1961 and he remarried. He was a first lieutenant in the Army during World War II and was awarded the Bronze Star with cluster. He was a chemical engineer with Mobil for 36 years, retiring in 1985. He and his wife, Eileen, had been living in Lakewood for the past six years.

Benjamin Lohr died a year ago. He graduated from the Naval Academy before attending MIT and retired from the Navy in 1961. He worked for TRW and Booz Allen Hamilton. He and his wife, Ruth, had been living in Silver Spring, Md., for many years. On behalf of our classmates, I extend our sympathy to their wives and their families.—**Marty Billett**, secretary, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

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For those who have been submerged under the Arctic ice for the last eight months and others who depend exclusively on this column for news of the world, you should know that on Monday morning, May 9, 1994, a police cruiser was found parked on the roof of the Great Dome, red and blue lights flashing, 100 feet above street level. That morning, a color photograph of the cruiser atop the dome adorned the front page of the *Boston Globe*. Other publications around the world followed suit. The *Globe* described the incident as a prank perpetrated by students. Not all ana-

The MIT Museum's new acquisition, above, can be seen in its original precinct on page MIT 61. (See Class of '49 column for more dope.)

lysts agreed. It is widely recognized that cold logic and calm reason guide the waking moments of every Tech man. But, one asks, how could this apparent prank have been logical and reasonable?

The answer comes from an informant in the student body who reports that the students were merely drawing attention to the horrendous shortage of parking space around the Institute. So, there you have it. However, if the students want their message to come across, let them realize that hoisting a car to the top of the dome is not the way to go. The Great Dome is not zoned for parking, and there is deep prejudice against those who would violate a city ordinance. A better strategy, and I am sure I speak for the class on this, would be for a committee to approach President Vest with plans for a high-rise parking garage straddling Memorial Drive.

When **Jan Peyrot**'s father was an engineering student at the University of Delft in Holland, a young mathematics instructor named Dirk Jan Struik was teaching there. Years passed and the elder Peyrot visited MIT with an eye to enrolling his son Jan. On a tour of the school, the elder Peyrot noticed the name Struik on a door and, later, wonderedif the man inside could be his university acquaintance of years gone by. At his father's suggestion, and having become a member of the Class of 1949, Jan dropped by Struik's office one day and found that, sure enough, it was the same man.

On September 30, 1994, Professor Struik celebrated his *100th* birthday by giving a centenary lecture at Brown University. Prior to that, the mathematics department at MIT paid fulsome tribute to Professor Struik's career. Jan found out about the Struik birthday in the Dutch language newspaper *The Windmill*, published in Vancouver, British Columbia. Translating from the Dutch, Jan kindly sent me the gist of what appears above. Included in the account was the statement: "Generations of mathematicians the world over have grown up with [Struik's] *History of Mathematics*."

The Council for the Arts at MIT is a volunteer group of alumni/ae and friends established to support the visual, literary, and performing arts at the Institute. Since its founding in 1972 by then President Jerome B. Weisner, the council has awarded over $800,000 to more than 700 arts projects created by MIT students, staff, and faculty. **Brad Endicott** is a member of the council and his wife, Dorothea, recently became amember also. Current members include New York State Council on the Arts Chair Kitty Carlisle Hart, architect I.M. Pei, '40, art historian Agnes Mongan, and arts patrons Leo Beranek, Vera List, and Raymond Nasher.

1994 Bronze Beaver Award

JOHN KUNSTADTER, '49
(See page MIT 11)

H. Douglas Vitagliano, 66, died of cancer on May 2, 1994, after a distinguished career as a mechanical engineer in the aerospace industry. His expertise in the design of space telescopes was employed at the Goddard Space Flight Center. When he retired in 1993, he was deputy project manager and designer of the Space Imaging Spectrograph that will be installed on the Hubble Telescope in 1997. He was the recipient of many awards from NASA during his career. He had lived in Columbia, Md., since 1964. Survivors include his wife of 42 years, Patricia, two sons, a sister, his parents, and two nephews. The class extends its sincere condolences to the Vitagliano family.

A cryptic, unsigned note received by the Alumni/ae Association reports that **John Patrick Regan** died in 1993. His address given in the note was 31-19 84th St., Jackson Heights, NY 11370. I deeply regret the lack of information. If any of you knew John, please write. I will see that he is properly remembered.—**Fletcher Eaton**, secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

50 45th Reunion

As the large type proclaims, we are the 45th Reunion class. Plan to spend the week beginning June 12 in Newport with us.

Clint Burdick sent a note commenting on last June's D-Day remembrance. (This gives you an idea of our leisurely production schedule.) Clint "was a young P-51 pilot protecting...men and material from Nazi aircraft." . . . **Bill Hall** wrote from Florida that he will attend our 45th. He retired in 1988 from Gibbs & Cox, naval architects in New York City, after 37 years. He had lost his wife in 1983 and, after retirement, moved to his home in the Pocono Mts. After eight years of living alone, he "met and married a wonderful lady, Betty." After two miserable Pocono winters they moved to North Fort Myers where they plan to spend many years "swimming, golfing, traveling, and shopping." . . . **Tom Keane** and I talked recently. He enjoys his senior technical position with Du Pont, where he has spent his career. His latest triumph is the reactor used to make Suva R, Du Pont's chlorine-free replacement for Freon 13 R. The ozone layer loves Tom. He had some serious surgery in June but now feels great and will join us at the Reunion. . . . Tom and his wife, Marie, dine frequently with another Du Ponter, **Art Wolters** and his wife, Pat. Art sent me a long letter recently. After he finished an SM at MIT, he began 34 years with Du Pont at six locations ending in Wilmington. Art and Tom both worked with fluorine; in Art's case it was in the production of Teflon R. Art retired from Du Pont in 1985 and began his current career as a consultant to the chemical processing industry. Art had some serious surgery in 1988 but is fully recovered now, awaiting only an aeromedical certificate so he can resume his flying hobby. He is also commander of the Wilmington Power Squadron. He is planning to attend the Reunion.

There is some sad news this issue. **James Daley** died last June at his home in Simsbury, Conn. Jim retired last year as executive vice-president of Shawmut National Corp. When he retired the bank established a college scholarship award in his name. Jim also was a corporator and director for Hartford Hospital. . . . **George K. Dawson** died last June. He lived in Menlo Park, Calif. He served as an Air Force pilot in Korea after leaving MIT. Kirby then got an MBA at Stanford and joined SRI International. He became director of the Minerals and Metals Group. After retiring he founded a commercial real estate venture in Los Altos, Calif. He also found time to research and promote the use of hybrid electric cars and cold fusion as a power source for homes and industries. . . . **Jack Martin** died last June. He lived in Bedford, Mass., and had worked for General Electric.—**Robert A. Snedeker**, acting secretary, Seven Mashie Way, North Reading, MA 01864; **John T. McKenna**, secretary, P.O. Box 146, Cummaquid, MA 02637

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The fourth annual Prix du Livres D'Astronomie for his authorship of the best book in French about astronomy and astrophysics written for the non-specialist was awarded to Professor **Charles A. Whitney** and Kenneth Lang. The prize, carrying an award of 15,000 francs, was given for the French edition of the book originally published in this country as *Wanderers in Space*. The seven French scientists forming the jury chose this book—the only one of the 11 finalists that did not have French authorship. The president of the jury in describing the book used the terms "merveilleux, superbe, très éducatif, avec des images intéressantes et des explications passionnantes." Professor Whitney is a senior scientist at the Smithsonian Astrophysical Observatory and professor of astronomy, emeritus at Harvard University.

Having served as chairman and CEO of Philbrick-Booth & Spencer, Inc., for the past two years, **William J. Callahan** becomes director and senior consultant in August. With his wife, Mill, he is enjoying four grandsons, traveling, golf, and skiing.

Sadly, we have received word of the passing of **George W. Hughes** on December 10, 1993. George and his wife, Dorothy had been living in Brookline, Mass. We express our sincerest condolences to his wife.—**Martin N. Greenfield**, secretary, 25 Darrell Dr., Randolph, MA 02368

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Paul Ries writes that he retired from Procter & Gamble in 1991, and that he still does some consulting work, but mostly just enjoys retirement. He and Betty celebrated their 40th wedding anniversary last August, and at the time of writing they were about to travel to Germany and Italy to visit old friends and their younger son, who is a consular officer in Rome. He says they still do a lot of cycling on their tandem bicycle, and go to Colorado for skiing in the winter. Paul's older son (MIT '80) works at MIPS Technologies.

Paul may be retired, but he is keeping up; he wrote to me by e-mail. E-mail may be up-to-date, but it also may not yet be reliable. I submit the copy for Class Notes by e-mail, and I was chagrined to discover that last October's column apparently vanished en route. I apologize for the loss, and I am including the lost material in this month's news.

A series of short Class Notes moved **John Fitch** to take pity on me and write an update on himself. Since the last time he wrote to me, four years ago, he has a new book and three more grandchildren to his credit. John has been retired from the MIT staff for 13 years now, and his chief hobby is genealogical research. His latest book, *Puritan in the Wilderness*, is a biography of his immigrant ancestor, the Reverend James Fitch, 1622–1702. It has won an award from the Connecticut Society of Genealogists. He is revising his first book, *English Ancestors of the Fitches of Colonial Connecticut*, and has begun a third book on the descendants of Reverend James. John and Mary have six children—four married—as well as four grandchildren, and are expecting another descendant this month. As pastimes from this pastime, the Fitches swim daily, travel, and collect Chinese art.

Robert Ely writes that after retiring as professor of physics at Berkeley, he has continued research at Lawrence Berkeley Laboratory and at the 2 Tev proton-antiproton collider at Fermilab. (2 Tev is the amount of energy it takes to lift a gram a little over 3 centimeters, a misleadingly unimpressive quantity.) He is also serving this year in Washington, D.C., as program officer of the Physics Division of the National Science Foundation.

I am sorry to report that **Hugh Robinson** died last June 18. Hugh lived in Wenham, Mass., and was an engineer with Design Technology Co. of Billerica. In addition to his degree in mechanical engineering from MIT, he had a degree in nuclear engineering from the University of Chicago. Before joining Design Technology, he worked for United Shoe Machinery Corp. He is survived by his wife, Joan, and a son and a daughter.—**Richard F. Lacey**, secretary, 2340 Cowper St., Palo Alto, CA 94301; e-mail: <lacey@hpl.hp.com>

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First, I want all of you to know that I enjoy the task (and it is just that) of being your class secretary, *provided* I receive information from you. Lest you have forgotten, you relegated me to this misbegotten role (remember John Nance Garner's comment on the worth of being vice-president of the U.S.?) not only one year ago, but also during two prior five-year terms. Yet I served faithfully and honorably. Now, however, I find that I am unable to generate more than piddling responses from you all and thus am unable to sensibly report on the affairs of our classmates. Put simply, during the past 12 months of my current tenure, I have received only four responses from you folk, *collectively*. Accordingly, I hereby put my employer—you, my classmates—on notice. If, starting six months hence (from the date I write this, which is September 20, 1994), I do not receive sufficient notes and comments from you to fill these monthly columns, then I shall resign. (In case you don't understand, the reason I'm giving you a six-month "window" is that *Tech Review* does not publish my column until three to four months after I submit it.) Unlike Bill Clinton, I will not keep changing my ultimatums. This *is* it. (Besides, the pay is lousy.)

Second, and much to the point, I received a much welcomed letter from **Gardner Perry III**, who said: "You have managed to poke my guilt button one too many times with your threats of filling the '53 class notes column with all manner of inane jibberish!" (Listen up, folks.) Gardner noted that he spent three and a half years with us but actually received an MIT degree in '61. (Let the record show that your class secretary was awarded an SB degree later than '53.) Gardner and Mary, his wife of 40-plus years, live in Vashon, Wash. (between Tacoma and Seattle), and enjoy a life that is too active to properly describe. Frequent trips to Alaska, California, and New England. Much driving, flying, hiking, climbing, boating, and socializing, and goodness knows what else. Gardner's career path is less straightforward but interesting nonetheless. He turned to meteorology (both privately and as a research technician and programmer at MIT); tried his hand at retail-store management (launching and operating a chain of seven stores selling backpacking equipment); developed small-business microcomputer software as a consultant; and set up and managed the NSCC computer lab. Recently (as well as during much of the above) he has been a computer-science or mathematics instructor in various Washington-area primary and secondary schools and colleges. Along the way, he completed an MBA in accounting and MIS, a master's in political geography, and a master's in political science, all at the University of Washington. Suffice it to say that his list of volunteer activities is very lengthy. (Sorry, Gardner, for cutting this short.)

Another gratefully received note came from **Albert Lee**, who is living in Hickory, N.C., and presumably is still with General Electric. (Albert: the latter fact came from the MIT *Alumni/ae Register*; if it is incorrect, please write me and I will make amends.) His note reads: "Did some consulting work for the U.S. Navy at Norfolk, Va., relating to transformers. Reinstated as a licensed professional engineer from the Commonwealth of Massachusetts. President of Kiwanis Club of Hickory (1993–94). Attended Kiwanis International Convention in Nice, France, July 1993. Continue as chair of IEEE Hickory Subsection."

Finally, I am sorry to report that **James Klupar** died early in 1994. Neither my files nor

those of MIT provide information other than that he was living in Sun City, Ariz.—**Martin Wohl**, secretary, 4800 Randolph Dr., Annandale, VA 22003, (703) 354-1747

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In our last report, we recounted the joys and major events of the 40th Reunion in June. More than 100 members of the class, plus spouses, families and friends, participated in the grand affair. As promised, we shall devote this report to news about classmates that has been gathered during and after the reunion.

Sally and **Ron McKay** made the trek from California to Cambridge and Nantucket to join in the reunion activities for the first time since the 25th. They were among the statistics in the West Coast earthquakes, their house suffering major damage earlier this year. But things are now back in shape, and the McKays, as always, remain calm. . . . **Warren Davis** retired several months ago, and he and Jeanne have moved to Tucson. They are concentrating on golf and where they will put down roots. . . . **Dick Wallace** retired from Sperry a few years ago, and he and Charlee are happily living in Albuquerque.

Bob Evans is in Tokyo, at Keio University, on a research fellowship. We extend our sincere sympathy on the death of his wife, Lois, last summer. . . . **Sam Armour** retired recently after 28 years with General Electric. He was with the nuclear power division, designing nuclear reactors for research and for commercial use, with special attention to assuring safe and economical operations at the 100-plus nuclear plants across the country. . . . **Joe Brazzatti** had to miss the reunion because his work with Conoco has taken him to Norway, but he promises to get to the 50th Reunion.

Paul Drouhilet completed over 34 years at MIT's Lincoln Laboratory a year ago and is now in Washington, D.C. He is working with the Federal Aviation Commission and thus fulfilling a long-standing desire to get involved with aviation. . . . **Carlos Rogerro** lives in Peru, but travels to the United States occasionally to help companies modernize their processes for the electrolytic refining of metals. His most recent trip was last April. . . . **Charles Smith** is keeping busy as a railroad equipment consultant with LTR Engineering Services. He gets involved in everything: designing, overhauling, and upgrading new locomotives and cars; investigating accidents; and reviewing operations, etc.

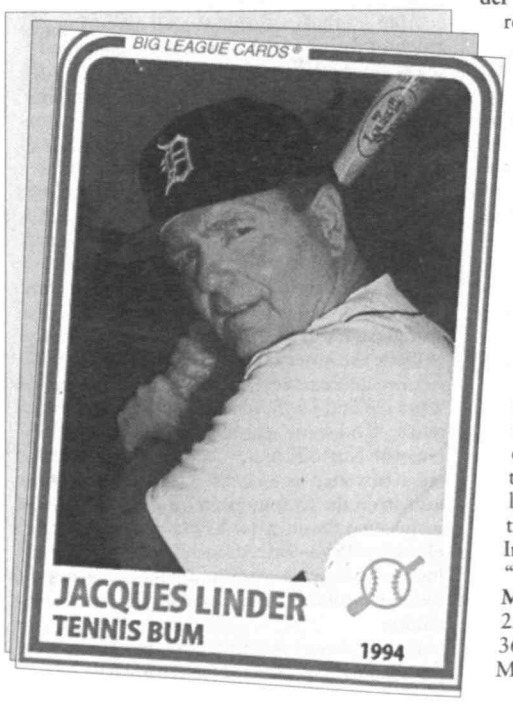
Dave Wiesen is dividing his time between New York and Vermont these days, and remains very active in the MIT Enterprise Forum of New York, as a member of the board and treasurer. . . . **Dick Neergaard**, who started off as a member of the Class of 1954 but graduated in 1957 after military service, has worked over the years for Procter and Gamble, including 16 years in that company's European operations. He retired in 1989 and lives in Cincinnati. He has four children, three of whom are working in Europe. His retirement activities include traveling, genealogy, art products, tennis, gardening, and "sundry inconsequential" activities.

As I reported in the last issue, **Bob Warshawer** is taking a sabbatical from his position as "permanent" reunion chairman, and **Dean Jacoby** has taken over for our 45th anniversary get-together. Dean suggests that we all mark our calendars *now* for "1999—The Millennium Reunion" to be held June 2-7, 1999. He promises an innovative program reflecting "the end of the 20th century and the changing lifestyle caused by retirement." You will be hearing more from Dean over the next few years.—**Edwin G. Eigel, Jr.**, secretary, 33 Pepperbush Lane, Fairfield, CT 06430

55 40th Reunion

By now, you have hopefully all received word that our 40th Reunion planning is going well under the co-chairmanship of **Ted Papastavros** and **Joe Saliba**. It will be held at the beautiful Black Point Inn on Prouts Neck, Maine. **DuWayne Peterson** and **Denny Shapiro** are co-chairs of the Reunion Gift Committee, from which you will no doubt be hearing, and to which we hope you will consider giving thoughtfully and generously.

In a nice note giving some fond remembrances of **Herman "Bud" Jacobs** (whose death was reported in the October issue), **Walter Shifrin** (Course I) also gave us some news of his own recent activities. Things are apparently going very well at Shifrin & Associates, Inc., which Walter started in 1988. They have a total staff of four and are really busy with a variety of environmental assignments: assessments for property transfers, site remediations, underground storage tank closures, expert witness work, etc. Walter's 26-year-old son, a history graduate of George Washington, is working with him while studying for a master's degree in environmental science. His 28-year-old daughter is studying for an MBA at Washington University in St. Louis, Mo., where Walter and wife Jennifer also live. They are now living at home alone and enjoying it, trying to travel as much as they can, but too busy to do as much as they'd like. They are, however, planning to take a three-week trip to the Orient this winter, sponsored by the St. Louis Symphony Orchestra, so life can't be *all* work.



David Brooks (Course XII-A) observes that our Class of '55 Notes seem to keep moving further and further forward in *Technology Review*, suggesting that *some* folks must be getting older! He also reports that he is now in his sixth year as director of the Environmental Policy Program at the International Development Research Centre (IRDC), a special part of Canada's international aid program—funded by but independent of the government. Their mandate is to fund research projects by Third World scientists working in their own countries, under the philosophy that the solutions to problems of "the South" will be found largely in the South. David's work takes him to parts of the world less frequented by tourists and, since his agency is focused on environmental issues, sometimes into the more rural and even wilder parts. One of the more satisfying aspects of his work in recent years has been his participation on the Canadian delegation to the Environment and Water Working Groups of the Multilateral Track of the Middle East peace process. His own research had been focused on the natural resource problems in the region and his book *Watershed: Water in the Arab-Israeli Dispute* was scheduled to be published this past fall. Meanwhile, wife Toby is busy as an instructor in an adult literacy program and they have celebrated 39 years of marriage. Daughter Naomi (now 36) is maintenance coordinator for a Toronto housing co-op that provides shelter for post-psychiatric clients, but her more important role is as mother of granddaughter Rosa Avrit, now nearly 3. David's son Jake, 38, is executive director of an organization of independent electrical power producers in Ontario, most of whom sell their output to Ontario Hydro. (This almost creates an intra-family conflict of interest, since until recently, David was on the board of directors of Ontario Hydro!)

One of the more fascinating stories about our classmates was received from **Jacques Linder** (Course IX-B), whom some of you may remember as our Senior Week chairman. Jacques and wife Joan have been retired and living in Sarasota, Fla., since 1985, playing lots of tennis and keeping busy with travel, keeping up with their kids' activities, etc. This past February, Jacques fulfilled a boyhood (if not lifetime) dream by attending the Detroit Tigers "Fantasy Camp" in Lakeland, Fla., and living the life of a major leaguer for a week, being coached by and playing with some of the all-time greats of that team. Jacques summarizes his adventure by saying "it went pretty well—I hit .429, pitched two scoreless innings, and fielded well." His baseball-card picture looked pretty convincing to me! He also wrote a much more extensive and colorful journal of his preparations for and attendance at the camp, part of which was serialized in a local Sarasota magazine, *Attitudes*. Since then, he and Joan have had a great trip to Indonesia and Hawaii to celebrate their "big 60" birthdays.—Co-secretaries: **Roy M. Salzman**, 10643 Montrose Ave., Apt. 2A, Bethesda, MD 20814; **James H. Eacker**, 3619 Folly Quarter Road, Ellicott City, MD 21042.

ClassNotes

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Henry Valcour, Jr., reports that he is manager of nuclear/industrial marketing & sales at Ionics Inc. He has published articles in trade publications on membrane-based ultrapore water treatment. He has five sons, one daughter, and three grandchildren. Henry enjoys sailing in his spare time and has vacationed in the Caribbean, Greece, and Australia.

A 40th Reunion planning meeting was held at the Faculty Club on September 26 with the following in attendance: Eliza Dame and Elizabeth Simon of the Alumni/ae Office, **Ted Korelitz**, reunion chairman, **Lloyd Beckett, Warren Briggs, Margolia Gilson, Bill Grinker, Ron Massa, Bill Northfield,** and **Ralph Kohl**. Your ideas are welcome. Please send letters to me and I will forward them to Ted.

David L. McBride III of Youngstown, Ohio, died on December 29, 1993. He received both bachelor's and doctoral degrees in metallurgy from MIT. He was founder and president of Innes Corp. since 1988, had been employed as first director of the Cushwa Center for Industrial Development for more than 8 years, and had been employed by Youngstown Sheet & Tube Co. for 17 years as director of production, planning and control. He was a member of First Church of Christ, Scientist, was chairman of the board of CASTLO Industrial Park in Struthers, and was a member of the boards of McDonald Steel Corp. and Jarrett Inc. of East Palestine. He leaves his wife, Jean, a daughter, and two sons.

Send news to **Ralph A. Kohl**, co-secretary, 54 Bound Brook Rd., Newton, MA 02161; e-mail: <kohl@ll.mit.edu>

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Joe Korbus writes from Phoenix, Ariz., that, although he missed the 35th reunion, he is still alive and kicking. He doesn't smoke as many cigars or drink any longer, so he can get up the high mountains in the area. He enclosed a picture of himself at the summit of Mt. Humphreys (12,650 ft.), complete with ear phones for listening to music.

The many friends of **John Hughes** will be saddened to learn that he died July 27 of multiple myeloma. He had practiced architecture since graduating from MIT and was a founding partner of the firm of Hughes and McCarthy, Inc., of Natick, Mass. He lived in Wellesley and had been active in professional and public activities. He was formerly director of the Metrowest Chamber of Commerce. He is survived by his wife, Jean, and three children.—**John Christian**, secretary, 7 Union Wharf, Boston, MA 02109

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Arthur H. Aronson was elected to the position of president and CEO of Allegheny Ludlum in Pittsburgh, Pa., effective August 1, 1994. The company's news release stated, "Under Aronson's leadership, Allegheny Ludlum has continually achieved even higher levels of productivity and efficiency through improved quality, yield, and utilization of our production facilities....Aronson joined Allegheny Ludlum in December 1988 as executive vice-president, following a long career in the specialty steel industry." Art received master's and doctorate degrees from Rensselaer Polytechnic Institute in metallurgy. Congratulations, Art!

1994 Bronze Beaver Award

ANTONIA SCHUMAN, '58
(See page MIT 11)

Another publication recognizing the outstanding accomplishments of a classmate appeared in the July 11, 1994, issue of *Automotive News*. **Kenneth Whipple** was named to the *Automotive News* All Stars in the finance category. The profile next to Ken's photo stated, "President of Ford Financial Services Group: A high-powered guy in a high-powered operation—savvy and smooth. A finance guy who worked on the auto side as head of corporate strategy and chairman of Ford of Europe during his 36-year Ford career." Kudos to you, Ken!

Just in case you missed it, turn to page 62 in the May/June '94 issue of *Technology Review* for a provocative essay by **Tom Magliozzi**. For a regular dose of his whimsy, tune in to hear Tom and his brother Ray as Click & Clack, the Tappet Brothers on their weekly call-in show, *Car Talk* on National Public Radio. It's a fun hour!

Well, the ballots have all been tallied and your new class officers are **Mike Brose**, president; **Cole Bess**, vice-president; **Al Russell**, treasurer; and yours truly as secretary. Our gratitude and admiration goes to the outgoing officers for a terrific job—**Bob Jordan**, president; **Steve Hadjiyannis**, treasurer; and **Mike Brose**, secretary.

The chairman of our 40th Reunion will be **Dick Rosenthal**, but you won't necessarily have to wait until then for a get-together. Mike has started the ball rolling on some interim regional mini-reunions. If you would like to be involved—e.g., organize, host, help to plan, be there, etc., just add it to the information you'll be sending me for the class notes.

This is certain to be among your first wishes for a Happy 1995 since its being written in September 1994, editorial lead times being what they are! Speaking of editorial matters, your classmates want to know what you're up to regarding career, hobbies, family, travel, public service, etc., so keep those cards and letters coming to: **Gary Fallick**, secretary, 4 Diehl Rd., Lexington, MA 02173.

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These notes are being written as the summer ends in New England, and the leaves are starting to fall from the trees. Time really does pass more quickly these days.

A note from **Herbert Priluck** reports that his reunion plans were overcome by the happy events surrounding the wedding of his youngest daughter, and that he is still, after all these years, a working civil engineer. "My steel-toe boots and hardhat are a great excuse for ducking a tie and jacket most days...when I'm tired of being in an office, I can always find a reason to spend time on the construction sites." He continues that "although the financial assets I've accumulated are modest, I've managed somehow to become rich in human assets. I have a lovely wife, Joan, and we have four great kids and two grandkids, with more to come, hopefully. The welcome mat is always out for Tech '59ers visiting Dallas."

Another event involving a number of our classmates was a mini-reunion in Taos, N.Mex., in August for the Phi Gamma Delta classes of '57, '58, and '59 (whose ages, interestingly, center around 59, 58, and 57). This was a weekend event, informally organized, and brought a total of 16 alumni and spouses to a beautiful part of the country. Most of the time was spend talking, sharing life experiences, and renewing MIT relationships (amazingly easy to do, even though some of us had not seen some there for 36 years!). In our class, attendees were **Joe Hendren, Al Beard, Larry Boyd, Bob Williamson, Al Kniazzeh,** and I. It was a wonderful, powerful, and fun time for all!

Kudos to **Fred Wan** on his appointment as vice-chancellor of research and dean of graduate studies at the University of California/Irvine. The announcement cites Fred as a fine administator and scholar well-known for his applied mathematical research. His role is to help faculty direct research toward new funding sources and move UC/I into the

Fred Wan

top 50 research universities in the country. Fred says "Because of competing demands and more targeted approaches...unless we position ourselves to tap new sources, we will not be able to increase our research activities." Fred was born in Shanghai, China, and grew up in Saigon before receiving bachelor's, master's, and doctoral degress in mathematics at MIT, where he was on the faculty until 1974.

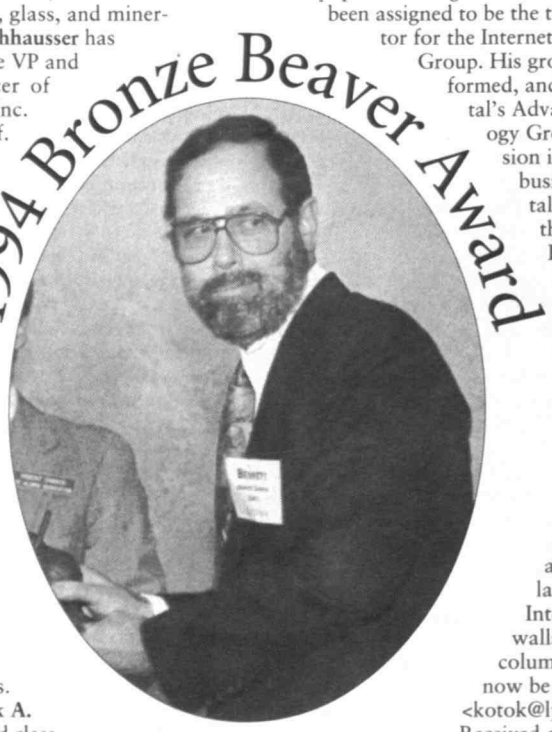
Finally, a note from **Paul Todd** expressing regret for missing the 35th, but looking to future opportunities. He works for the same "boss" (University of Colorado) as classmate **Pete Kuempel** whom he sees often. Paul says that over the past three years he has become almost "fully retreaded" as a chemical engineering professor, and that his wife, Judy, is engaged in re-entry to a career as a professor of nursing. He ends by mentioning their two granddaughters in Pennsylvania.

That's all for now. Thanks to those who have contributed, and again I urge you to *actually do it*—to send an update which will be most appreciated by your classmates.—**Dave Packer,** secretary, 31 The Great Road, Bedford, MA 01730, (617)275-4056

60 35th Reunion

This is barely going to qualify as Class Notes, as I have received nothing except what was forwarded by the Alumni/ae Association. Please help your poor scribe!

Richard Bradt recently presented one of the memorial lectureships at the annual meeting of the American Ceramic Society. Dick, who is a professor of materials science engineering at the Mackay School of Mines, University of Nevada at Reno, talked on the hardness of ceramics, glass, and minerals. . . . **Frederick Rehhausser** has been named executive VP and chief operating officer of Ampro Computers, Inc. in Sunnyvale, Calif. Congratulations, Fred! . . . **Noel Bartlett** and I talked recently. Noel is heading our 35th Reunion gift campaign, and you should be hearing from him or one of our classmates helping him in the near future (if you haven't already). Noel also said that our reunion committee has selected the Stage Neck in Ogunquit, Maine for our reunion festivities. See you there!—**Frank A. Tapparo,** secretary and class agent, 15 S. Montague St., Arlington, VA 22204



BENNETT ZARREN, '61
(See page MIT 11)

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Please send news for this column to: **Andrew Braun,** secretary, 464 Heath St., Chestnut Hill, MA 02167, or via Internet: <andrewb820@aol.com> or <abraun@husc4.harvard.edu>

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Bardwell C. Salmon (aka Bard, Bojey, MIT Class of 1962 President from 1962 to 1987, etc.) has been appointed chairman of the Technology Capital Network at MIT. This was formerly located at the University of New Hampshire. Its purpose is to match up new technology businesses with private investors with substantial individual net worth. A "NASDAQ for folks with big bucks." Bard was formerly president and CEO of Laser Plot, Auburn, Mass., and is now associated with Eagle View, a high-tech start-up firm in information technology working with multimedia networks and addressing the needs of buyers and sellers of goods and services. So if you have "substantial individual net worth" and are interested in investing in new technology businesses, get in touch with the Technology Capital Network at MIT, 201 Vassar Street, Cambridge, MA 02139, (617) 253-7163. Or if you want to explore information technology/multi-media networking, I'm sure Bard would also be happy to talk with you (even without "substantial individual net worth"—after all, he did get back to me!).

Orrin J. Getz dropped us a note that he is working for the New York State Urban Development Corp. in New York City as director of Office Automation. Orrin also serves as chairman of the Rockland County Transportation Advisory Council and as president of the New York SL-1 Users Association.

An e-mail message from **Alan Kotok** at Digital Equipment brought the news that Alan has been assigned to be the technical director for the Internet Business Group. His group is newly formed, and part of Digital's Advanced Technology Group. Their mission is to develop business for Digital by expanding the value of the Internet to DEC's customers. He is presently concentrating on servers for the World Wide Web, as well as Internet "fire walls." I'll try to get more information about the insulation used in Internet "fire walls" for a future column. Alan may now be reached at <kotok@ljo.dec.com>. Received a nice long e-mail message from **Richard A. Reitman**. You might recall from a recent column that Richard works for Space Systems/LORAL in Palo Alto, Calif., and is a member of the board of directors of the Wild Dolphin Project. He and his wife, Diane Levine, are still living in Menlo Park, Calif., and Diane works with KENTRO Body Balance, which is a means of minimizing back problems through stretches and mechanically sound posture. Richard serves as supervisor of multiuser systems in the Information Systems Directorate for Space Systems/LORAL, designing and building various communication satellites. He can't believe that our classmates have reached their mid-50s (broadly defined—have you looked at your mid-section lately?). He is quite enthusiastic about the Wild Dolphin Project, a long-term research project studying the lives of spotted dolphins "in their world, and on their terms." Research is being conducted while free diving with the dolphins in the Atlantic, north of Grand Bahama Island. The director of the research program is Denise Herzing, an internationally respected expert on spotted dolphins who has been seen on National Geographic Specials, on PBS (*Nature*), the BBC, and featured in many cetacean-oriented publications. Richard is quite enthusiastic about this "thrilling part of [his] life!" He also spends time in the mobile disk jockey business, dba "Star Sounds!" He has discovered a group of fraternity brothers (Tau Epsilon Phi) in the Bay area who continue to remain close after "all these years." Richard would like to see more news from our classmates and urges our readers to keep in touch with MIT1962 on the Internet.

Naturally, I agree with Richard, and request that if you have access to the Internet, please put a message through to: <MIT1962@mitvma.mit.edu>. Alternatively, you can send a message directly to me at: <uabhnm01@asncube.asc.edu>. If you still communicate by traditional methods, please send your news and personal notes to: **Hank McCarl,** secretary, P. O. Box 352, Birmingham, AL 35201-0352

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Please send news for this column to: **Shoel M. Cohen,** secretary, Dept. of Psychology, Nassau Community College, Garden City, NY 11530; e-mail: Internet <71271.2627@compuserve.com> or Compuserve <71271,2627>; home phone (516) 489-6465

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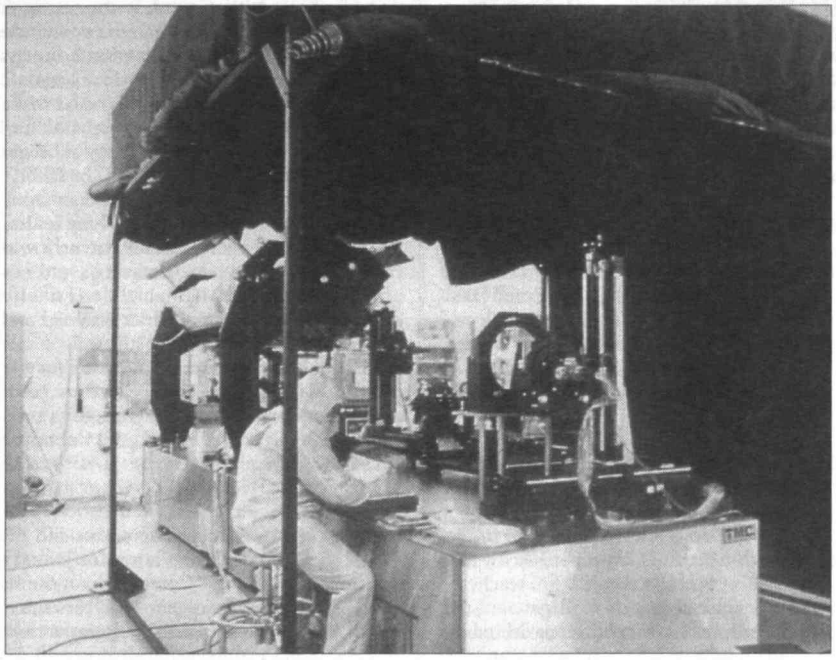
Stephen Portnoy was named a Fellow of the American Statistical Association. The designation is a singular honor and for more than 75 years has signified an individual's outstanding professional contribution and leadership in the field of statistical science. The American Statistical Association, which was founded in Boston in 1839, is one of the country's oldest professional associations. Early members included Alexander Graham Bell, Herman Hollerith, and Martin Van Buren.

Stephen received a PhD in statistics from Stanford and from 1969 to 1974 was an assistant professor at Harvard. Currently, he is a professor in the Department of Statistics at the University of Illinois. His research areas

ClassNotes



The Repair of a Space Telescope Begins With a Good Place to Work.

When NASA designed and commissioned the construction of what amounted to a set of glasses for the nearsighted Hubble Space Telescope (HST), the project depended on a vibration-free table built by Technical Manufacturing Corp. of Peabody, Mass., founded by Ulf Heide, '60. The key component in the repair of HST was the Corrective Optics Space Telescope Axial Replacement (COSTAR), and it was installed in a spectacularly successful space walk in December 1993 by the crew of the Space Shuttle *Endeavor*. COSTAR was built by Ball Aerospace and Communications Group, Boulder, Colo., on a table supplied by Heide's company. TMC tables are used in such sensitive applications as semiconductor manufacturing, microbiology research, and optics.

include "robust statistics," which apparently describe those areas for which normal Gaussian distribution doesn't apply.

Stephen's wife, Esther, is a professor of actual science at the university. They met at the MIT Science Fiction Society and have two children, ages 26 and 28.

This fall **Stan McKenzie** will begin his 28th year at Rochester Institute of Technology. He started teaching at RIT while finishing a PhD at the University of Rochester, and never left. His teaching focus is primarily on Shakespeare, but with occasional courses on Mark Twain, Jonathan Swift, Milton, or J.R.R. Tolkien. When he first offered Tolkien four years ago, it had the largest attempted telephone pre-registration of any course in the history of RIT, including the always popular "Death and Dying."

For most of his 16 years, Stan has been director of Judicial Affairs (shades of JudCom). One year he served as acting dean of the College of Liberal Arts and has spent the last two years working on strategic planning with the "new" president, Al Simone, who received a PhD from MIT in economics in 1962. Simone recalled that while we were all trying to get into Samuelson's classes in the early 60s, he was the graduate fellow next door teaching the overflow sections. Stan has recently been appointed interim provost and VP for Academic Affairs.

The only other major event in Stan's life has been when he served as his own general contractor in building a hedonistic house back in 1987–88. He writes that he learned an incredible amount and could really do it right next time, but the major thing he learned is not to do it again! Stan has one son, age 27, who after graduating from SUNY/Brockport with a double major in philosophy and psychology, is currently contemplating graduate school.—**Bill Ribich**, secretary, 18 Revere St., Lexington, MA 02173, (617) 862-3617

65 30th Reunion

Bill Brody left Johns Hopkins to become provost of the Academic Health Center at the Unviersity of Minnesota. He is in charge of seven academic departments plus the hospital at the university (14,000 people) and is trying to help them deal with the changing health care world. Among his responsibilities is their branch in Duluth, which trains rural and native American primary care physicians (an area of focus). This will be Bill's first winter in the far North, since he was born in California.

We have quite a number of influential classmates in the health care field. In late October, I joined **Ron Newbower** for a two-day session he had organized at MGH to review health care directions. Gel Sciences, which moved in September to a 22,000-square-foot facility in Bedford, has also recently set up a majority owned affiliate, Gel Med, to focus on medical applications of our technologies. I continue to serve as president of both in addition to my venture activities.

As I write this, we are in the midst of the primary election season. **Dick Armstrong** once again is tilting at the windmills with a run for Massachusetts State Senate from the district that includes Falmouth. Dick is running as a Republican "to make Massachusetts a crucible for the two-party system."

Bruce Sunstein moved his law firm to new offices recently. I suppose it had nothing to do with a $25M+ award he won for one of his patent clients! . . . **Ralph Cicerone** was recently appointed dean of physical sciences at University of California/Irvine.

Remember, the reunion is only a few months away! Write when you can.—**George McKinney**, secretary, 33 Old Orchard Rd., Chestnut Hill, MA 02167, (617) 232-4710; e-mail: <gels@world.std.com>

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The e-mail correspondents outnumbered the regular mail this month. **Bob Marsh** writes that he is running a branch office of a computer and networking-oriented consulting firm in Atlanta called Valinor. Their consultants work closely with Microsoft to apply Microsoft's vision and product suite to big businesses' data-processing needs. Bob has done a lot of software development in his career for a variety of clients, i.e., NASA, the Alaskan pipeline, the FBI, and McDonald's. He was also project manager responsible for two Microsoft product releases. Bob's wife, Aurora Isaac, is a PhD candidate in neuroscience at Emory University. Their children, Kendra and Corwin, are still in elementary school, but Bob does have a niece at MIT. He still favors hiking, skiing, and exploring in his free time. . . . **Dan Dedrick** writes that he continues as director of residency education for anesthesia at the Brigham and Women's Hospital. Other than his son, Benjamin, transferring to Tufts this year, all is stable and copacetic in his life. Dan can't seem to interest any of his brood in the "wonders of an MIT education.". . . **Stuart C. Shapiro**, professor of computer science at SUNY Buffalo, was elected a Fellow of the American Association for Artificial Intelligence, and **Rowland M. Cannon**, staff scientist at Lawrence Berkeley Lab, was elected a Fellow of the American Ceramic

Society. . . . **Wesley Richardson** was appointed quality assurance manager for Herron Testing Labs for both their Cleveland, Ohio, and Charlotte, N.C., locations. Herron provides mechanical testing, chemical analysis, metallography, failure analysis, and welding certification services for both government and private industry. After MIT, Wes earned an MS in metallurgy from Case Western Reserve and an MBA from the University of Kentucky. He is both a certified quality auditor and certified quality engineer. . . . I seem to be closing too many columns this way but we have lost another classmate. **Edward C. Wert** died last April in Downingtown, Pa.—**Eleanore Klepser**, secretary, 84 Northledge Dr., Snyder, NY 14226-4056; e- mail: <vismit66@ubvms.cc.buffalo.edu>

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Jim Gips was selected as a finalist in the *Discover* magazine "Technological Innovations Award" for 1994 in the area of Computer Hardware and Electronics. Jim teaches Computer Science at Boston College. . . . **George Sacerdote** has joined Mercer Management Consulting as a VP in its Lexington office. The team he joined is dedicated to helping companies in the global computer, telecommunications, entertainment, and information industries to meet the challenges associated with the rapid convergence of these previously disparate industries. George has been a consultant for 14 years, focusing on corporate strategy and development, marketing, and business reengineering for companies in the information industry. He was previously with Arthur D. Little, Inc., where he led that company's information and entertainment practice. . . . **Joe Levangie,** the Chief Executive Officer of JEL and Associates in Bedford, Mass., has become a director of Food Integrated Technologies, Inc. in Brookline.—**Sharlotte** and **Jim Swanson**, co-secretaries, 878 Hoffman Terr., Los Altos, CA 94024; e-mail: <jswanson@lat.com>

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Not much news this month. Actually, for the first time in 26 years we have no alumni/ae fund envelopes in the IN box—probably due to a change of mailing dates by either the Fund or *TR*. In any case we went to the Alumni/ae Leadership Conference this year. **Steve Finn** received the Henry B. Kane Award for exceptional service in fund raising. The citation read, "The Institute recognizes Steve for his consummate role as the Class of 1968 25th Reunion Gift Chair. An Educational Council member since 1977 and a telethon volunteer, Steve undertook the challenge of trying to raise a generous 25th Reunion gift. Through persistence, outstanding leadership, and organizational skills, he was able to create a new sense of unity for his class, while providing MIT with a substantial gift.". . . Both of your class secretaries received the George B. Morgan Award for excellence in Educational Council activity. Gail's citation read: "As the current regional vice-chairperson of the Montgomery County subregion, Gail interviews a significantly higher number of prospects than the national average for Educational Counselors. Despite this substantial demand on her time, she performs her work with great attention to detail, always maintaining contact with other counselors in the area and offering assistance when needed. Gail is the first female recipient of the Morgan Award." And Mike's citation: "This distinction goes to Mike for his service in the Montgomery County subregion of Washington, D.C., since 1975. In 1982 Mike became regional vice-chairperson along with his wife, Gail. Through his long tenure he has been able to interview an extremely wide range of students while increasing awareness of MIT in the area. Mike's high level of efficiency and expertise make him a valued and respected volunteer to the Institute."

That's all for this month. We look forward to hearing from you.—**Gail** (ghm@nrc.gov) and **Mike Marcus** (mmarcus@fcc.gov), secretaries, 8026 Cypress Grove Lane, Cabin John, MD 20818

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God, it's September and I'm preparing notes for January 1995! Coming up on the big "three-oh"—30 years since our high school graduations. I suppose many of us will dutifully attend those next summer to find out, among other things, what happened to those old girlfriends or boyfriends, and how many of those who just didn't "get" calculus and physics are now successful merchants, multimillionaires, or whatever.

Well, you folks haven't sent me any notes recently, so I'll use that excuse to devote much of this column to one classmate. No, I'm not pushing his book! I haven't even read it. I just think it's interesting and exciting news.

Frank Tipler

At least one of us has hit it big time in what looks like a potential best-selling book, or at least one that is destined to be highly controversial—nay, already is. **Frank J. Tipler**'s book, *The Physics of Immortality: Modern Cosmology, God, and the Resurrection of the Dead*, is already making big waves. All the science book clubs are running it as a main selection. The publisher, Doubleday, had a full-page color ad for it in a recent *New York Times* Book Review section. Before you know it, our friend Frank will be on Leno's and Letterman's shows, and then on to Rush.

This is what interviewer Sebastian Thaler wrote in the Library of Science promotion: "He may not be religious in the traditional sense, but Frank Tipler, professor of mathematical physics at Tulane University, has strong views on God, immortality, and resurrection. God's existence can actually be proven using the laws of physics, Tipler contends. In his new book, *The Physics of Immortality*, Tipler not only shows how God (a/k/a the 'Omega Point') emerges from accepted cosmological theory, but explains that human resurrection and immortality can and will take place in the far future.

"Tipler is no stranger to controversy: his

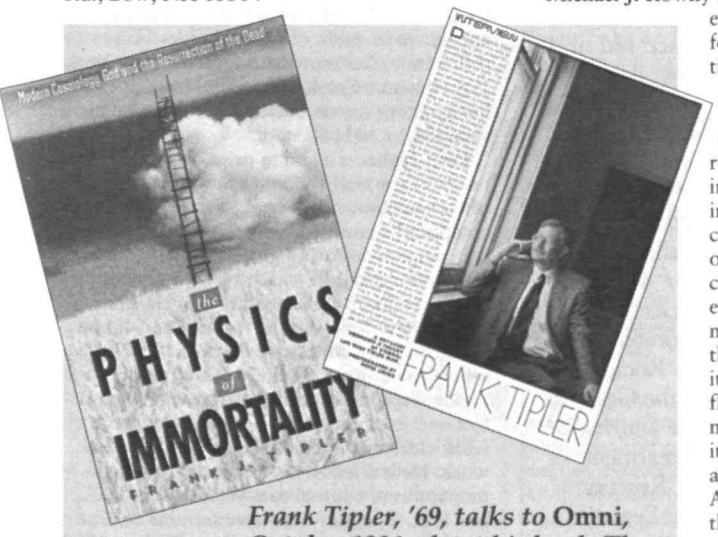
1986 book, *The Anthropic Cosmological Principle*, written with John Barrow, strengthened many people's belief that humans play a unique and powerful role in the Universe's evolution. The scientific arguments in his new book are disconcertingly plausible, and should convert many who are now convinced that science and religion are forever strangers."

The *New York Times* ad boldly proclaims, "The clash between science and religion began with Galileo. It ends here." It portrays a wheat field with a ramshackle wooden ladder rising toward the heavens. A reviewer in *Esquire* magazine is quoted: "It's *2001: A Space Odyssey* meets the *Divine Comedy*." And Tipler is quoted: "I never imagined when I began my career as a physicist that I would one day be writing that Heaven exists." In the book, Frank reportedly states that he began his career as a committed atheist.

As expected, the reviewer in *Nature* magazine, mathematician George Ellis, was not kind. He opened his review, "Piety in the Sky" with: "This must be one of the most misleading books ever produced. It has a great air of authority and seems highly erudite, covering vast areas of knowledge in a polished way. There are perceptive comments on a wide range of topics throughout. Yet underneath this facade lies wishful fantasy and a total lack of intellectual rigour. It is a masterpiece of pseudoscience." Later we read: "What one would have assumed was just an undergraduate joke is here presented as if it were a serious theory. . . . [the book] does not take seriously either science or theology—or indeed its readers." Hah! The book *must* be good, *Nature*'s reviewer hates it!

That's all folks, except for the sad news that after publishing three acclaimed issues of *Cold Fusion* magazine, deep disagreements arose between the editorial staff and publisher Wayne Green—not a pleasing puppy, that Green! We editors are off looking for other pastures to revive the magazine. Stay tuned.

Those of you who are fully electronic can reach me or submit class notes at Compuserve <76570,2770>. Via the Internet, use this form: <76570.2270@compuserve.com>.—**Eugene F. Mallove**, secretary, 171 Woodhill-Hooksett Rd., Bow, NH 03304



Frank Tipler, '69, talks to* Omni, *October 1994, about his book,* The Physics of Immortality. *See Class of '69 column for more details.

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Raul Arriaga tells us that he is now a director and major shareholder of a logging and service oil company in Venezuela after having worked in the Venezuelan oil industry for more than 15 years.

Peter Kramer writes that he went back to school to get an MBA from Columbia University and then took the MBA and joined a small biotech company, Immunicon, as vice-president of business development. He says, "Just like the good old days. I'm buying and selling . . . technology."—**Greg** and **Karen Arenson**, secretaries, 125 W. 76th St., Apt. 2A, New York, NY 10023

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Jerry S. Greer became manager of Demand Side Management Program evaluation at Boston Edison in January 1994. . . . **Donald G. Roth** moved to London this summer with J.P. Morgan Investment to handle various investment analytic systems. He says that he's looking forward to a change of scenery and a much shorter commute than in New York.—**R. Hal Moorman**, secretary, P.O. Box 1808, Brenham, TX 77834-1808

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Larry Kelly reports that his daughter, Megan, 11, has entered the Castilleja School in Palo Alto and loves every minute of it. His 8-year-old son, Jamie, is a star at soccer. Their new dog, Cody, another golden retriever, is chewing up everything in the house. In the past year, they went bare-boating in the Caribbean for Thanksgiving, and went to Cape Cod in the summer. . . . **Thomas Eager** is now the director of Metallurgical Engineering at Simpson, Gumpertz and Heger. He continues as the POSCO Professor of Materials Engineering and co-director of the Leaders for Manufacturing Program at the 'Tute.

Michael J. Rowny has rejoined MCI as executive VP responsible for oversight of operational alliances and ventures relating to the company's network MCI strategic vision. His responsibilities will include MCI's ventures into wireless and personal communications services, once the transactions are consummated; MCI's entry into local telecommunications markets through MCI metro; and its investment into in-flight air-to-ground communications services; and its international business alliances on the North American continent. At the 98th annual meeting of the American Ceramics Society, **George W. Scherer** gave the Sosman Memorial Lecture, sponsored by the Basic Science Division. He spoke on the physics of Drying, and is in the Central Research Department at Du Pont. Apparently the depth and quality of the delivery of the talk were superb.

Congratulations to **Adrian Bejan** who won the 1994 ASME Heat Transfer Memorial Award in the "science" category "for significant and often unconventional contributions to heat transfer, notably in natural convection, thermodynamic aspects of heat transfer, convection in porous media, thermal tribology, solar energy conversion, cryogenics and transition to turbulence; and for bringing modern research results and methods into heat transfer education." He is the J.A. Jones Professor of Mechanical Engineering at Duke University.

I am sorry to report that **Robert A. Lentz** has died, although I do not have any further details on his death.

And that's it for now. I hope that you all have had a great holiday season, and that the end of the year brings even more news to report next time.—Co-secretaries: **Wendy Elaine Erb**, 6001 Pelican Bay Blvd., Apt. 1001, Naples, FL 33963; **Dick Fletcher**, 135 West St., Braintree, MA 02184

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Robert Fritzsche is serving as a regional chair for the Baltimore area for the MIT Educational Council, which means coordinating applicant interviews and promoting MIT to aspiring youngsters—a noble calling. He is an architect in his remaining time, with RTKL Associates, and appeases his muse as president (and baritone) with the Arion Gesangverein.

Alan Lehotsky writes electronically: "A recent issue of *Technology Review* included the announcement that I was VP of Technology at OEC. By the time this was published, I'd already left OEC to start an independent consulting practice—Quality Software Management. QSM specializes in software process improvement using Deming's quality philosophy and TQM as the axiomatic basis. I also attended the Burton Third Bombers 25th Annual DTYD Party on Patriots' Day weekend. Actually, I only made it to the alumni hockey game. Present were representatives of classes between '66 and '93. The game ended up being between the even and odd class years. The even years slaughtered us."

From **Larry Esposito**: "I saw your e-mail address, and here's the latest on my activities. . . . I am still married to Diane McKnight, '75, and we still live in Boulder, Colo., with our kids Rhea ('04) and Ariel ('08). I still do space research at the University of Colorado, and Diane remains in the National Research Program of the USGS Water Resources Division. Her field work ranges from Rocky Flats in Colorado to Taylor Valley in Antarctica. I am the principal investigator for the ultra-violet imaging spectrograph on NASA's Cassini Mission to Saturn, and am developing a proposal for a space mission to Venus to be run by the University of Colorado. This mission would address the history of the Venus atmosphere

ClassNotes

Rock Doc David Relman, '77

Regular readers of the *Wall Street Journal* know that they can always look to the fourth column on the first page for news with a light touch, like a profile of "Dr. Dave," the rock doc. David Relman, who earned an SB in biology at MIT in 1977, went on to earn an MD at Harvard Medical School and is now one of 30 physicians and hundreds of other medical personnel who volunteer for the Rock Medicine Program of the Haight Ashbury Free Clinics.

The *WSJ*'s Michael J. Ybarra watched Relman in action backstage at the basketball stadium at the University of California/San Jose campus, while the band Sepultura played out front, and his report on the mayhem appeared on September 9.

Rock Med claims to be the only program of its kind, treating everything from drug overdoses to parking-lot muggings among concertgoers in the San Francisco Bay area. Although there have been deaths at mega-musical events, no fatalities have been recorded on Rock Med's watch.

"A lot of kids come to shows with the expectation of experiencing minor traumatic injuries," Relman was quoted as saying. Indeed, the only dismay Ybarra seem to detect among victims whose heads had been slammed against railings or whose bones had been broken, for example, was over the fact that while they were being treated, they were missing the music. "I think it's a status symbol to leave a little bloodied or at least bruised," observed Relman.

Of course, not all concerts are created equal, medically speaking. "If you give me the name of the band, I could tell you the kind of injuries, " Relman told Ybarra. Heavy metal bands attract the most rambunctious crowds, while reggae shows are relatively sedate, he said, thanks to the soothing effects of marijuana. On the other hand, "you'll never see an LSD problem at a Barry Manilow concert."

At the Sepultura concert where Ybarra watched Relman in action, the doctor treated 15 patients—one of them twice—by 11 p.m., when he knocked off for the night. A young man complaining of pain in his ribs after being pushed into a barricade didn't seem to have broken ribs, but Relman tapes him anyway. Within the hour, noted Ybarra, the youth was back. He tried to stay out of trouble by hanging out in the back of the arena and got pummeled anyway, arriving in the clinic with a nosebleed and half his face red and swollen.

Relman's father, Arnold, made the family name a household word in the world of science journalism when he was editor of the *New England Journal of Medicine*. Now David Relman works with an organization that collaborated with the competition: in 1992 Rock Med collaborated with fans of the Grateful Dead on an article for the *Journal of Psychoactive Drugs*, "Treatment of Acute, Adverse Psychedelic Reactions: ' I've Tripped and I Can't Get Down!'"

Dr. Dave has a day job as a researcher in microbiology at Stanford University. □

and compare it with Earth's, as part of NASA's new policy of 'faster, cheaper, better.' Diane and I continue to enjoy hiking, camping, and traveling with our kids."

Let us hear from you, too. Write or e-mail!—**Robert M.O. Sutton, Sr.**, secretary, "Chapel Hill," 7721 Churchill Ct., Marshall, VA 22115; e-mail: <sutton_bob@prc.com>

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Lloyd Thompson writes that he has completed 20 years with General Electric Aircraft Engines. How many of us can make a similar claim?! He's currently general manager of the Small Commercial Turbo Fan Department in Lynn, Mass. He must be busy as his products serve corporate aviation and the new regional jet with commuter and regional airlines. (I'm jealous of the four years he spent in market development in Rome, covering Italy, Yugoslavia, and Malta in the mid-'80s.) Lovely wife and three children keep him otherwise occupied.

Bob Puckett, wife Gay (who would've guessed—a Wellesley grad!), and two young children live in Austin, Tex. Another classmate whose industry is keeping him busy, Bob is designing workstation computers for IBM. He went to Illinois-Urbana for an MSEE after MIT. And to prove there is no cure for this particular affliction, a quote from Bob: "And yes, Austin has great rowing!"

William Young is about to experience what my own brother just went through—retirement! (I shudder at the prospect.) He's currently a major in the Air Force at Tyndall Air Force Base, Florida. He'll have his 20 years in shortly. He hasn't played much tennis lately (remember, he was #1 for MIT in 1974) but enjoys mountaineering and flying when he can. He has lived in Germany and Spain, and "almost" got to fly in Desert Storm. He recently received a master's in aeronautical science. Most activities revolve around sports, his two children, and wife Linda.

Frank Morgan is the chair of the Mathematics Department at Williams College in Williamstown, Mass. Frank was recently elected to the council of the American Mathematics Society. He's planning a sabbatical that appears to be more of a world tour—Australia, Italy, Germany, and Queens, New York City! I'm sure Frank is busy looking through his directory for classmates to look up on his vacation, er, sabbatical!

Peter Huber is again in print. (It is fun reminding myself I should know these people I often read about elsewhere.) Peter recently completed a study for the regional Bell operating company lobbying group. Showing his MIT training is still with him, he describes his qualifications: "I'm a pundit." For those of us who haven't followed the telecommunications industry, Peter wrote a well-known 1987 report to the Justice Department arguing regional entities cannot exert monopoly control over essential telecommunications network elements, and has recently updated his work. He is a fellow at the Manhattan Institute and is of counsel to a Washington, D.C., law firm. You may also have seen his column in *Forbes*.—Co-secretaries: **Dave Withee**, 1202 Linden Dr., Mt. Pleasant, IA 52641; **Barry Nelson**, 65 Hillside Ave., W. Newton, MA 02165-2543

ILLUSTRATION: JON McINTOSH

ClassNotes

75 20th Reunion

If some of this news seems somewhat non-new, it is because I am catching up on some previously missed columns. Anyway, better late than never. **Michael Bissell** is still working for Bechtel in Kingsport, Tenn. He writes, "My wife and I are no longer alone—Hilda Catherine was born August 21, 1993! (She definitely is a greater responsibility than the two cats!)" . . . **Sandra K. Fillebrown** is still teaching math and computer sciences at St. Joseph's University in Philadelphia. Her two boys, Scott (age 8) and Dennis (age 6), are showing an interest in both subjects. Though her job and being a mom keep her busy, Sandra has become interested in the sport of orienteering.

From several news sources, I have learned that in April 1994 **Ilene S. Gordon** became VP of operations for Tenneco, Inc., of Houston, Tex. She directs company-wide efficiency and quality-improvement programs, leads the development of a company-wide management planning and control system, and has responsibility for other quality initiatives, including ISO 9000 certification. Ilene is also a director of Zenith Electronics Corp. of Glenview, Ill.

According to an article that appeared in the *Boston Globe* last spring, **Barb Diederich** and her husband are members of a blue grass band called Yankee Division. Barb plays bass fiddle. The band has performed at the Cantab in Cambridge, placed third in the 1993 Pemi Valley Festival in New Hampshire, performed in the Joe Val Festival, did a benefit for Bosnian relief at B.U., and shared a bill with Alison Krauss at Harvard.

From a Philips Laboratories press release, I have learned that in June 1994 **Babar Khan** was one of two top scientists who received a Philips Technical Achievement Award. This award honors researchers whose work on highly advanced concepts displays exceptional initiative and competency. Babar was recognized for inventing a new, ultra-miniature, low-cost lighting technology called MicroLamp, for which he has received a U.S. patent. The MicroLamp is a new lighting element that is based on semiconductor manufacturing processes. It has the potential to produce powerful, inexpensive, ultraminiature lighting that can be customized to a wide variety of shapes.

Gray Safford writes, "On June 1, 1993, I took over the duties of the retiring director of engineering at the Drever Co., although my title as chief engineer remains unchanged. On February 11, 1994, my wife, Hillary, gave birth to a daughter, Susan Lee Safford. Her 2-year-old brother, Daniel, seems thrilled. With them, work duties, designing a new house that we will build this fall, and writing this has consumed my spare time for the month."

Cleve L. Killingsworth, formerly senior VP of Blue Cross and Blue Shield in Rochester, N.Y., has become president of Kaiser Permanente-Ohio in Cleveland.

I regret to inform you of the deaths of classmates **Leon A. Herreid** on March 7, 1994, and **Jeffrey L. Star** on June 20, 1994.

That's all the news for now. Apologies for missing a few columns. Column deadlines have fallen when I have been out of town on business. Please keep writing.—**Jennifer Gordon,** secretary, 18 Montgomery Pl., Brooklyn, NY 11215

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The mails, both postal and "e", have been very slow. Please write or call; we do need your news!

We also need your e-mail addresses. We have about 114 class members on our e-mail list, which is growing in use and usefulness. Please join our electronic dialogue.

In our printed version of the Notes, we will no longer be publishing classmates' addresses or phone numbers. They can be obtained from me privately. A caveat passed to me from the Alumni/ae Association, which I believe you must be made aware of is: "...people try to impersonate being an MIT graduate and this information [address and phone number] can assist them."

From the assorted mails, **Richard McAddoo** writes tersely: "New job. Oh boy! Thompson Financial Services. Boston. Computer programming. GO INDIANS!". . . **Marilyn Taggi Cisar** writes: "Al Cisar, '73, and I have been in the Houston area for the last 16 years and we love it here. We're finally settled in our new home after moving from far southwest Houston (Sugar Land) to far northwest Houston (Cypress) last fall. I'm a staff geological engineer developing South Texas gas fields at Shell and Al is manager of electrochemical energy conversion and storage at Lynntech, a small research firm at College Station, Tex. We've managed to stay involved with MIT through the local alumni/ae club and the Educational Council. I thoroughly enjoyed being president of the MIT Club of South Texas last year, and Al is president this year. It's been a great opportunity to meet other alums in the area, including classmate **Mark Suchon,** who has turned his skills from *The Tech* to good use editing our local MIT newsletter. The biggest news Al and I have is the birth of our daughter, Cecilia Taggi Cisar ('16?) on Feb. 1, 1994. She's a happy baby and a wonderful addition to our lives.... I haven't heard anything from Connor 3 folks in years—is anyone still out there?"

From **David Roberts**: "Have been at the National Institutes of Health for the last 11 years and currently am a section chief in the National Cancer Institute. I am doing basic research on the mechanisms of tumor metastasis as well as developing some new therapeutics based on our results. The research is exciting, but the bureaucracy is seriously in need of 'reinventing.' My two boys, Ben, age 11, and Jamie, age 7, keep me occupied away from work."

As for your secretary, he continues to work to make his computer business grow. It is still quite primitive out there, with lots of opportunities, especially in telecommunications. And I continue to trade for my own account, albeit less aggressively than when I was younger. We still live in volatile times, which is a blessing for traders, and a curse for investors.

Remember, please send news.—**Arthur J. Carp,** secretary, Quantalytics, Inc., 220 Henley Rd., Woodmere, NY 11598-2523; tel: (516) 295-3632, fax: (516) 295-3230; e-mail: <quantalyt@aol.com>

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Please send news for this column to: **Ninamarie Maragioglio,** secretary
P.O. Box 10315
Burke, VA 22009-0315

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We are without any news tidbits from classmates this issue. Please take a moment and write, call, or fax. It really only takes a moment, and you'll be starting off the new year right!

All the best to you for 1995!—**Jim Bidigare,** secretary, 9095 North Street Rd. NW, Newark, OH 43055-9535, (614) 745-2676, fax: (614) 745-5648

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Happy New Year! **William Fejes, Jr.,** has been named the president of Pacific Scientific Company's new Motion Technology Division, located in Charlestown, Mass. William has been with the company since 1986, and has headed the company's Charlestown operation since 1990. William originally entered MIT with the class of '78, but left in 1979 with both a bachelor's degree and a master's degree in course VI. . . .

William Fejes

Frank Caserta, Jr., received a PhD in physics from Boston University in 1992 and is currently a postdoctoral fellow at the Boston University School of Medicine. He and his wife, Lisa, have a daughter and a son.

I regret to announce the death of **Siong Huat Chua** last August of complications from the AIDS virus. Siong lived in Brookline, Mass., and worked as a computer programmer and analyst at the Dana-Farber Cancer Institute in Boston. He was also active in the gay community and was a founding member of the Boston Area Gay Men and Lesbians, which later became the Alliance of Massachusetts Asian Lesbians and Gay Men, the first gay Asian organization in North America. He wrote on culture and politics for the *Gay Community News*, and was a member of the board of directors of the Gay and Lesbian Advocates and Defenders, where he organized forums on immigration and law. Siong was born in Malaysia, emigrating to the United States in 1974. Our sincere sympathies go to his fami-

ly and his companion.—**Sharon Lowenheim,** secretary, 98-30 67 Avenue, Apt. 6E, Forest Hills, NY 11374

80 15th Reunion

Only three notes this month: **Louis Nagode** and his wife, Jenni, relocated last summer from Colorado Springs to Minneapolis. After 13 years of engineering and field technical sales work, Louis kept a commitment he made 14 years ago—to follow Jenni back to school to pursue her educational and career goals. She is starting a seven-to-eight-year process of getting an MD/PhD at the University of Minnesota. Meanwhile Louis has taken on the role of "Mr. Mom" for their two children, Melanie (11) and Paul (8). He continues to work 30 hours a week as a systems engineer for the same company he worked for in Colorado, Cadre Technologies. He says he is looking forward to being a "kept man" when he's 50!

An article in the *Cambridge Chronicle* is the source of information on **Michael Benjamin.** Michael is president of Cybergear, which has just turned his dream, a virtual-reality exercise bike, into a reality. While exercising you can "ride" through a small New England town, off on a side road or take part in a race. A small fan and varying resistance from the pedals gives one the "real" experience. The bike was due on the market last September.

The last news item comes from **Eric Beckman.** Eric and his wife, Joanne, celebrated the birth of their second child, Austen John, on June 5, 1994. Their oldest child is Ariane. As of September 1994, Eric is working at the University of Pittsburgh as an associate professor in the Chemical Engineering Department.

How's your winter going—lots of skiing or enjoying some sunshine? Send your news to: **Kim Zaugg,** secretary, 549 Fairfield Rd., Canton, MI 48188, (313) 981-1785, <vayda@erim.org>.

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Please send news for this column to: **Mike Gerardi,** secretary, 3372 Olive St., Huntington Park, CA 90255, (213) 587-2929 (h), (310) 553-5050 (w).

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Robert Sawyer writes that he just received a PhD in psychology from the University of Chicago. His research focuses on improvisational creativity, such as jazz performance and improvisational theater. He has relocated to New York City, where he is developing a portfolio management system at Citibank during the day, and teaching at The New School and writing academic articles at night. He has taken advantage of the recent affiliation between the Alumni/ae Association and the Princeton Club. He recommends it to everyone.

Heidi Hammel is head of the team analyzing the Jupiter comet crash from the Hubble Space Telescope. . . . **Steve Taylor** works for Workframe, Inc., in Cambridge. Workframe provides business process analysis and design services, as well as re-selling ActionWorkflow software and providing implementation support. He is getting married (for the first time) on May 21st to a wonderful woman named Rosemary Daley. Congratulations, Steve!

Rush Record passed away in October 1993. No further details were available.—**Helen (Fray) Fanucci,** 502 Valley Forge Way, Cambell, CA 95008; <FanGroup@aol.com>

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Not a lot of news this month, but once again we will try to make up for lack of quantity with quality. **Matt Haggerty,** president of Product Genesis, Inc., was recently featured as a guest on the radio show *The Business Beat,* Massachusetts' only radio show devoted entirely to local business. Matt discussed the history of his company and its unified approach to product development and design. Product Genesis has 40 mechanical and electrical engineers, industrial designers, and model makers. It has so far developed more than 100 products. A recent product, developed for PerSeptive Biosystems, won a 1994 Businessweek/IDSA Industrial Design Excellence Award—Best Products of the Year.

No one wrote in this month. We can only assume that no one got promoted, no one got married, no one had any children; and no one knows of anyone else who got promoted, got married, or had children.

Please keep those cards and letters coming.—**Jonathan M. Goldstein**, secretary, c/o TA Associates, High Street Tower, 125 High St., Suite 2500, Boston, MA 02110, fax: (617) 574-6728

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This month's column features significant contributions by e-mail. The list of electronic subscribers continues to grow. Please send me your address if you haven't yet.

Rob Pokelwaldt recently married Andrea Guay on August 27th at the Wellesley chapel. Rumor has it that various MIT attendees turned into "pirates" and donned cloth napkin bandanas at the reception while drawing "black beards" using burnt wine corks. Included among the motley crew was the groom's father. Luckily, a good time was had by all and there were no casualties. Rob recently relocated from New York to Atlanta, where he is working for Lever Brothers (the soap company). Rob claims that he's really cleaning up.

Steve Knapp sent a long update. He was responsible for opening Xilinx Asia Pacific, his company's first office in Asia. "I've been doing sales in Asia for almost four years now. Originally, I started out in Tokyo. Tokyo was an awesome experience. Despite the incredible expense, it's a lively, fun city. Where else in the world can you go skiing indoors on a hot summer day? Tokyo has the world's only(?) indoor ski slope—complete with real snow and two high-speed quad chair lifts!

"Currently, I'm living in Hong Kong, which sports one of the most beautiful skylines in the world. Despite the beauty, it's not always the easiest place to live. Sure, it's fun and always interesting but it's almost the anti-Tokyo. Whereas Tokyo is clean, efficient, polite, and usually hassle-free, Hong Kong is usually rustic, inefficient, pushy, and fraught with hassles. The crowds become overwhelming at times, especially for a country bumpkin like myself. After my Hong Kong experience, I will never complain about California being too crowded, too expensive, or too polluted.

"The job certainly has its fringe benefits, though. I've had opportunities to work and play in Japan, South Korea, Taiwan, Hong Kong, Macau, Mainland China, Singapore (and I didn't even get caned), Malaysia, Thailand, Australia, New Zealand, and India. If you want to see diversity, don't go to Europe—see Asia!

"All good things come to an end. I'll be relocating back to Silicon Valley this November. I'll be the corporate applications manager, responsible for our technical marketing. I'm really looking forward to the California lifestyle again—especially copious Mexican food. I'll be moving back into my townhouse in Santa Clara. In order to prepare for a more laid-back attitude, I'll be decompressing down in New Zealand and Australia for a few weeks before I return. I'm going on a black-water rafting adventure (white-water rafting but inside a cave) in Waitomo, New Zealand. Then, it's off to Cairns, Australia for some diving on the Great Barrier Reef. The diving there is like swimming in somebody's tropical fish tank with wildlife and coral of every imaginable description. So, that's my life in a nutshell."

David Lingelbach writes, "My wife, Jenny, and I moved to Moscow, Russia, in March 1994, where I am Russian country director of Citizens Democracy Corps, an American nonprofit organization assisting Russian businesses in the transition to a market economy. This position follows 10 years as a commercial banker in Wisconsin and Pennsylvania and an assignment as a volunteer adviser with CDC in Bulgaria last summer. We are delighted at the birth of our first child, Caitlin Stephanie, on July 24, and welcome any contacts from MIT alumni/ae living in or visiting Moscow."

Kevin Soch and his wife, Pamela, just had twins, bringing their brood to a total of six children all under the age of 6: four boys and two girls. They may stop now with a coed volleyball team and not continue on to a baseball team. They are still living in California on a ranch with horses and chickens. Kevin is at Hughes, where he has been since graduation. They were on the *Donahue* show on a program about family values. So there is life after MIT after all.

Mike Reese writes to say, "I actually consider myself a member of the class of 1985, since I did VI-1A and got the SB and SM together then. I suppose officially I am a member of the class of 1984, though. My wife, **Leola (Alfonso) Reese**, and I worked for several years as engineers, and now we are halfway through PhD programs at UC/SB: Leola in cognitive science and I in electrical engineering."

Ken Zeger also wrote a short note to inform everyone that he is still an assistant professor of electrical engineering at the University of Illinois at Urbana-Champaign.

"I have never sent an update before," writes **Rich Feld**. "I got married about 100 years ago to **Annette Avner**, whom I met in the MIT Kosher Kitchen. We have two daughters, Peninah (4) and Elana (1.7). The four of us live in lovely suburban Teaneck, N.J., while I commute to Long Island and the market research company, Norman Hecht Research. My job of senior VP/general manager gives me some freedom to work on the kinds of projects I like—generally new media, telephony and broadcasting. Sorry I missed the reunion, but two kids seemed like too many to bring hacking. My e-mail address is <richfeld@aol.com>."

Tricia Kellison and husband, Christopher Linn, '87, are proud to announce the birth of their first child, a daughter—Emilia Annette Kellison-Linn.

Friends of **Steve Dubnik** will be proud to note that he is currently president and CEO of ACC TelEnterprises Ltd. in Toronto.

One more Silicon Valley Guy: **Ira Leventhal** writes that his 10-year career at HP has culminated in the position of R&D project manager. (That's amazing. The longest job I've ever been able to keep has been my current one, just short of three years.) Ira and his wife, Laura, have two children, Jonathan, age 4, and Amanda, age 1. He spends his fun time swimming, playing guitar, and driving around in his convertible.

And finally, I thought folks might enjoy this bit of humor:

Top 10 Reasons Why **God** Never Received Tenure at any University:

10. He had only one major publication.
9. Some even doubt he wrote it himself.
8. It may be true that he created the world, but what has he done since?
7. His cooperative efforts have been quite limited.

6. The scientific community has been unable to duplicate his results.
5. He never applied to the Ethics Board for permission to use human subjects.
4. When one experiment went awry he tried to cover it up by drowning his subjects.
3. He expelled his first two students for experimenting.
2. Although there were only 10 requirements, most students failed his tests.

And the Number 1 reason why **God** never received tenure at any university: His office hours were infrequent and usually held on a mountaintop. —**Jonathan Miller**, secretary, 78 Roosevelt Cir., Palo Alto, CA 94306, tel: (415) 494-7430, fax: (415) 813-1130; e-mail: <jonathan_miller@logitech.com>

85 10th Reunion

Greetings, everyone. I just returned from the 1994 Alumni/ae Leadership Conference at MIT. Attending from 1985 were Treasurer **Anita Killian**, Class Agent **Dave Fung**, **David Libby**, and **Douglas Chin**. As part of the meeting we held a conference call with **Stephanie Winner** and President **Inge Gedo** to begin the planning of our 10-year reunion. The reunion will be Thursday, June 15 to Sunday, June 18, and our class will have events on Friday night (mixer with hors d'oeuvres and music), Saturday evening (dinner and music), and Sunday (brunch with officer elections.) Details on locations, price, etc., will be passed along as they become available. Mark your calendars!

Dave Sherman and **Jim Hutchinson** held a combined bachelor party at Dave's house in Hebron, Conn., because their weddings were only three weeks apart. To make this a true MIT event, Dave, Jim, and Dave's best man, yours truly, decided to hold a 2.70-like team design contest as part of the afternoon festivities. With cardboard boxes, wood, plastic, bags, and other assorted junk, the assignment was to build a raft within two hours, and then traverse the lake near Dave's house. Other MIT participants: **Marty Rauchwerk**, **Andy Renshaw**, and **Gary Sabot**. Appropriately, the best men—the team including Jim's brother, Marty, and myself—were victorious by constructing the only one of the three rafts which remained afloat during the entire round trip. Second was the team including Dave, whose raft made the round trip, but not above water. The team of treacherous dogs, Andy, Gary, and Jim, who cheated by hiding barrels in their boxes, were unable to even leave the shore due to poor structural design. Said Marty, "I have new respect for Gilligan and the crew of the S.S. *Minnow*."

In the procreation department we have reports of two new members of the Class of 2016. **Dan Weidman** and wife Sue had a metric baby girl, Pamela Leandra Weidman, on September 21, 1994. Vital statistics are 3.01 kg. and 49.5 cm. Both Pam and Sue are fine. Also, Tamar Yonina Katz was born August 30, 1994. The proud parents are **Kenneth Katz** and his wife, Amy.

Steve Knapp, '84, reports that **Mike Ho** is finishing a PhD at the Darden School at the University of Virginia. Mike has recently rejoined RCS & Co., a San Francisco investment banking firm, as a VP for a newly formed venture in Shanghai, PRC. Mike worked for RCS & Co. previously before retiring early (27) to obtain his doctorate. Mike recently married Connie Gilbert on September 10 in Charlottesville, Va. True to form, Mike ran a 10K road race before the ceremony. (I hope he showered.) The newlyweds plan on moving to San Francisco sometime after the first of the year, by which time Mike hopes to have finished his doctoral thesis.

That's all for now, gang. Submit news by writing a note on the back of a $20 bill and sending it to **Bill** I-can't-afford-to-be-invited-to-any-more-weddings **Messner**, 5927 Alder Street, Pittsburgh, PA 15232, (412) 361-4180; Internet: <bmessner@andrew.cmu.edu>, class listserver: <mit1985@mitvma.mit.edu>.

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We could use a few more letters coming in each month, so read this column carefully to learn more about a terrific incentive for writing in soon.

Henry Woo has been working for Bellcore in New Jersey ever since graduation. In his first year of "work," he spent a year at the Univ. of Pennsylvania getting a master's in computer science, and shared an apartment with **Paul DiMilla** (now known as Dr. DiMilla). Henry returned to Bellcore to develop data communications software, but then was promoted to district manager in 1991, and later promoted to director of network communications development. Since he'd been in management for a while, he went back to Penn in May 1994 to attend Wharton and work on an executive MBA. He plans to finish in two years while continuing with work. Henry keeps in touch with other alums as well: one of his closest colleagues at Bellcore is Yi Tso, '85. **James Toh** recently contacted Henry from Michigan, on a hot management consulting assignment from his Singapore base. Henry welcomes e-mail at <woo@cc.bellcore.com>.

Speaking of Paul DiMilla, he wrote in himself to report. After finishing a postdoc at Harvard in the summer of '93, he's been an assistant professor in chemical engineering at Carnegie Mellon University for over a year. Paul is enjoying his job in Pittsburgh very much, and looks forward to hearing what's become of other alums from MacGregor, particularly Course X alumni/ae.

On the parenthood front, **John Swartz** reports that he is a dad. His wife, Carol, gave birth to their first child (a girl—Kristen Elizabeth) on June 13 (born on her due date—"unusual for first children, but we engineers like to be precise!). It was an incredible experience, I felt like I was back at MIT after having pulled an all-nighter." Being a father has meant a lot less time spent on himself, but one smile from his daughter makes it all worthwhile. John, his wife, and new daughter live in Winchester, Mass., and he is working for the MITRE Corp. . . . **Robert Jones** writes that he finally launched his first "restertainment" concept called Rhythm and Spice in January '94. The restaurant is located between MIT and Central Square on Mass. Ave. and focuses on Caribbean cuisine, entertainment, and retail products. The restaurant has received several good reviews and has been featured in *The Tech*, *Boston Business Journal*, and other publications.

ClassNotes

Vic Christensen is happily back in southern California, and writes that he made it to the LA Air Force Base and has been in the Brilliant Eyes SPO since Dec. '93 as chief of information systems. He also writes that **Bruce Kristal** was visiting from Texas to interview with USC. . . . **Jennifer Solomon** is living in New York and working on Wall Street. As of this writing, she's been married 2.5 years to Bill Feingold. She keeps in touch with **Pam Loprest, Karen Spencer, Mike Liebson, Bob Huang,** Loretta Miraglia, '85 (who just had a baby), Caroline Van Rijckeghem, '85 (who just got married), and Steve Eliot, '83.

I, Bill Hobbib, caught up with **Kim Hunter, Sharon Israel,** and Rhonda Peck, '83, at the recent Alumni/ae Leadership Conference at MIT. A session on "Leading for Excellence" put on by MIT's Training and Development Program was great, as were sessions on "Mens Et Manus: The Intersection of the University and the Industry."

Now for the incentive to write in—a survey! That's right, we've got a simple question for you to answer, and when you respond, go ahead and also include a couple of lines about what you've been up to lately. Here's the question: "What is the one thing MIT could do better to more effectively meet your needs as an alumnus/a?" We'd like to get a high response rate, so keep it brief—there's no need for essays. The preferred response media is e-mail, but postcards, letters, sky-writing, and/or hot air balloons are also permitted. Class of '86 responses will be compiled and a summary forwarded to the appropriate people at MIT, as well as printed here in this column. The deadline for receiving responses is February 5, so get those pens and keyboards out today.—**Bill Hobbib,** secretary, 5 Cappy Circle, West Newton, MA 02165; e-mail: <hobbib@cognex.com>

87

Greetings, I hope you had a great holiday! Just got back from the 'Tute, and it is amazing to see how things have changed—you would not recognize some of the classrooms which have been recently renovated—like 6-120 and 3-190. Some, though, are exactly the same—even painfully so. I visited 26-100, and could not stay there too long, because I was afraid that someone was going to hand me an 8.02 quiz to do. And in 10-250, (the site of the Alumni/ae Leadership sessions), the impulse was the same as always—grab and read *The Tech*, then promptly doze off (though not for long, since the ALC program was much more exciting than the 18.02 and 6.002 lectures I slept through there 10 years ago).

Other classmates attending the meeting were **Charles** and **Wendy (Cone) Gilman,** who are on the MIT Educational Council, as well as **Jim Koenig** (our class agent) and his wife, Class President **Stephanie Levin.** When I told Wendy my 10-250 impulse, she replied that Charles' impulse was to sit in the back row, so that when he fell asleep, his head could rest on the wall behind him. (Wendy vetoed that idea.) Charles is still working on a PhD at RPI, while Wendy just got a master's, and started a new job with SUNY—the State University of New York system.

But enough about the class "grease." Via **Adam Kane,** I received some e-mail from **Dave Carter,** who is working on his thesis at Los Alamos after finishing up all of his class work at UC/Santa Barbara. He bought a house in Santa Fe, and expects to stay at the lab for a couple of years while he finishes up thesis work. In his spare time, Dave has begun auto racing again—he bought an RX-7 from a friend who moved to Europe, and spends time keeping the car race-ready. Adam also added that his honeymoon trip to Vancouver, Victoria, Seattle, and points in between was great fun. It sounded like the highlights were the white-water rafting trip that he and his wife took past Mendenhall Glacier, as well as the boat trip into Glacier Bay which took them past glaciers 200 feet high by a mile wide.

James Cross sends us his update: He and his wife just had their third child, Emily Brown-Cross, who was born a week early, on September 20, 1994. Tipping the scales at 9 lbs., 12 oz., Emily joins brothers Cameron, 3, and Zachary, 2. James seems to be a bit worried about the speed at which they are growing up, and has even started to extrapolate his kids from the piece of children's software they recently received at the Athena fishbowl! Don't worry, James—I'm sure that it will feel like a long time 'til they are all through the "terrible twos.". . . From Jacksonville, Fla., **Alex Chow** wrote in that he and his wife, Theresa, just had a baby girl, Jessica, born on

January 24, 1994. . . . **Lynn (Schlactus) Folds** and her husband, Joe, had their first child, Joseph, just before Christmas 1993. Lynn works for International Paper at their corporate research center, in the areas of product and process development. She and Joe have been living in North Jersey for three years now, and just recently bought their first house there.

Tony Mercado married Juli Blumenthal on June 26, 1994. The wedding reception was held at the Manor in West Orange, N.J., and they honeymooned for two weeks in Hawaii. There, they visited four islands, learned to snorkel, and generally had a blast. Notable events during the wedding weekend included the trip home from a memorable bachelor party that caused a set of car mats to be left on the interstate (y'all can figure out the reason for that yourselves). The groom himself claims not to have been present for that. Also, during the reception, the "gang" hacked the hotel room that Tony had stayed in the night before. Only the last laugh was on them, since Tony had already checked out! Attending the wedding were the New House IV crew: **Bob Durie, John Kwon, Steve Kardon, Jenny Gleason,** Al Fullerton, '88, Todd Barber, '88, **John Nguyen,** Trish Wilson, '90, **Gus Lopez, William Wegerer** and his wife, Susan, Coimbatore (Venkat) Venkatakrishnan, '86, and **Sumanth (Sam) Kaushik** and his wife, Bhuvana. Bob is working on a PhD at Cornell. John Kwon has been in the New York City area for the past three years. He received an MBA from New York University's Stern School of Business last year, and since then has been working for Coopers and Lybrand in the area of strategic restructuring practice. Also in NYC is Venkat, who is working for JP Morgan. In Boston, Steve Kardon is working as an information systems consultant. John Nguyen is also in Boston, and works for Applied Language Technologies, a company involved in the field of speech recognition. He finished a PhD last year, and completed a postdoc at the University of Michigan in Ann Arbor before moving to Boston. Somewhere between Michigan and Boston, John also found time to get married to Trish Wilson, '90—a busy year. Sam and his wife, Bhuvana, were also married last year, in India. Sam just recently finished a PhD and is about to start working for Sandia Labs in New Mexico. Gus Lopez is at the University of Washington working on a PhD in computer science. Jennie Gleason (a New House III, rather than IV person) is working on a PhD at Yale University. Todd Barber works at JPL in Pasadena as a propulsion engineer for the Galileo mission to Jupiter. Al Fullerton lives near Boston and works for TASC. Bill and Susan Wegerer both work for Alliant Techsystems, a spin-off of Honeywell in Minnesota. As for the bride and groom: Juli works for Bankers Trust as a portfolio manager, and Tony is still a programmer/analyst at Lehman Brothers in Manhattan. He does not at all regret his move to the financial world.

I-Chun Lin e-mailed from Stanford, where she reports that she just received a master's degree in sociology. She is continuing there for a PhD. As they say at political conventions: "Four more years.". . . **Michael Thomas** has been trotting the globe recently. Though he lists a permanent address in Fairfax, Va., Michael has just finished a stint in Georgetown—Georgetown, Guyana, that is, where he was director of the U.S. Information Service at the Embassy there. He is now in Lisbon, Portugal, where he will work as the U.S. Embassy vice-consul. No wonder the Alumni/ae Association lost track of him! . . . Other alumni/ae who have strayed far from the Institute include **Yang Meng Tan** and **Tze-Yun Leong,** who were married in September 1991. Both have just completed PhDs in computer science at the Institute, and they are now in the process of setting up their new apartment in Singapore. Yang Meng will join the Singapore National Computer Board after completing 10 more months of National Service; Tze-Yun has joined the Faculty of the National University of Singapore where she is teaching in the Department of Information Systems and Computer Science.

Closer to home, **Susan Swales** has been promoted to the position of manager in the Cleveland office of Andersen Consulting/Arthur Andersen and Company. She completed an MBA from the University of Miami in December 1988, and joined Andersen the following January. . . . **Turan Erdogan** felt inspired to write in after reading one of our on-line columns. After completing a PhD at the Institute of Optics at the University of Rochester in 1992, Turan spent two years at AT&T Bell Labs in Murray Hill, N.J., doing research on fiber-optic communications devices and systems. While at Bell Labs, he and his wife, Mary, had their first child, Michal Ann, born June 29, 1993. This past September, Turan joined the faculty of the Institute of Optics at UR. He is busy learning how to teach, trying to get an experimental research program going, and spending time with his family.

Susan Swales

We have lost track of several people who were on the MIT1987 e-mail list until recently. If you have e-mail addresses (or any other information) for the following, please contact either the Alumni/ae Office (mitalum@mitvmc.mit.edu) or your class secretary: **Sameer Ghandi, Linda Marinilli, Stan Oda, David Lin, Elizabeth O'Neill, Robert Gilgen, Mike Mountz, Douglas Singleton, Jerrold Cline, Mary Landrum,** and **Aleks Nikolich.** Thanks!—**Jack Leifer,** secretary, 2908 Roses Run, Aiken, SC 29803; work: (803) 648-6851 x3279, home: (803) 642-3900, fax: (803) 642-2700; e-mail: <leifer@ccwf.cc.utexas.edu> or <MIT1987@mitvma.mit.edu>

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Happy New Year, classmates! Hope all is well with you and your families. For those of you making New Year's resolutions please add: "I will write to my class secretary with my latest news."

Congratulations to Captain John Ostrowski, who hired a plane to fly over a sports stadium with his marriage proposal trailing behind. The flight was a success and **Cheryl Sampson** will marry John this January. Cheryl received a medical degree from the Uniformed Services University in Bethesda, Md., and is currently serving as a physician and lieutenant in the U.S. Navy. John graduated from the Naval Academy and has received his wings of gold. John is a UH-1 helicopter pilot in the Marine Corps.

Darrell Mavis graduated from Harvard Law School in 1991. Darrell has been prosecuting criminals as a deputy district attorney for Los Angeles County. . . . **Massimo Russo** started Harvard Business School this September. Massimo is married to **Farla Fleming Russo.**

Timothy C. Benner recently returned from a six-month deployment in the Mediterranean Sea aboard the destroyer USS *Arthur W. Radford*, homeported in Norfolk, Va. Timothy's ship participated in joint exercises with Romanian, Bulgarian, Israeli, French, British, German, Dutch, Turkish, Spanish, Italian, and Tunisian navies. During the visit, Timothy was able to visit Italy, Turkey, Bulgaria, Romania, Israel, Greece, Spain, and France. On this excursion, Timothy's ship sponsored tours of such places as the Vatican, Pompei, Mt. Vesuvius, and Count Dracula's Castle in Transylvania!

I have spent the last month flying around in a P-3, testing out a system that I have been developing. The system worked great, but I may never recover.—**Catherine Singer,** secretary, 131 Main St., Andover, MA 01810-3804; <singer@mit.edu>

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Lisa Robinson writes that "The class calendar is great!!" There are still a few left (not many), which can be had by sending voluntary class dues of $10 to me.

This month's hit list is: **Darrin Bonecutter, Kimberly Haskins, Walter Metz, John Ryan,** and **Andrew Yee.** What are y'all up to? If anyone knows about any of these people or anyone else, please write in.

Matt Rita and his family moved to Colorado in October, and Matt has promised to send more news after his move. . . . **Jim Reich** is now studying in the Electrical and Computer Engineering Department at Carnegie Mellon, "fleeing the aerospace industry in search of greener minefields."

Melanie Ryan-Graham writes to say that "This year has been exciting. I was just married on May 28, 1994, to Kenneth Bray Graham, and we were so excited to have classmates **Laura DiGiacoma, Donna Kessel,** Jaclyn Ho, '90, and **Susan Streisand** attend. Kenny and I were on our honymoon in Ireland during the Class Reunion, but would have loved to see everyone."

Susmitha Bellam and Ron Baakkonen, SM '93 (Sloan), were married in June in the backyard of Susmitha's parents' home in Jonesboro, Ga. **Anjali Arora, Rosina Samadani,** and **Anu Vedantham** were her bridesmaids. Anu writes that they "all had a great time pulling the wedding together, arranging the guests' chairs, making corsages, etc. The wedding was beautiful, held overlooking a lake, and enjoying Georgia's summer weather. The ceremony had just finished when a huge thunderstorm started!" Susmitha and Ron are now working and living in London. Anu just started a new job in the Technology and Information Infrastructure Assistance Program (TIIAP), in the Department of Commerce, next to the Wash-

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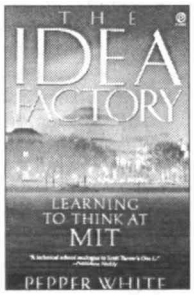

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The Language Instinct

by Steven Pinker *Professor and Director of the Center for Cognitive Neuroscience at MIT*

Steven Pinker lucidly explains everything you always wanted to know about language: how it works, how children learn it, how it changes, how the brain computes it, how it evolved.

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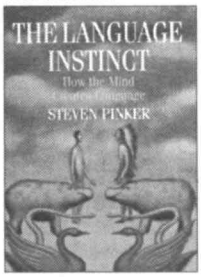

The Knot Book

by Colin C. Adams, '78

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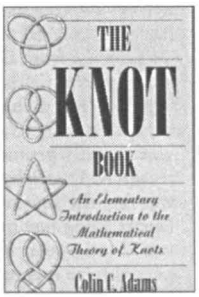

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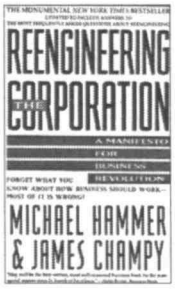

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by Alan Lightman
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A novel.

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"A wonderfully odd, clever, mystical book of meditations on time, poetically spare and delightfully fresh." **Chicago Tribune**

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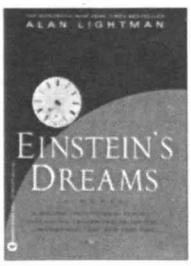

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ington Monument in D.C.

Mike Fincke, who was on the "hit list" a few months ago, wrote in with a bunch of news (thanks, Mike!). "Last year I was selected to attend the Air Force Test Pilot School at Edwards Air Force Base, where upon my recent graduation from the one-year-long Flight Test Engineer course, I was 'recognized as a Distinguished Graduate and Top Flight Test Engineer, receiving the prestigous Colonel Raymond L. Jones Trophy.' Test pilot school was even more intense than MIT; however, in terms of flying it was more fun. I gained over 170 flight hours in 27 different airplanes from the Goodyear Blimp to the Navy's hot F-14D Super Tomcat."

After graduation from the Test Pilot School, Mike spent one month on vacation as a volunteer for the U.S. Geological Survey learning the ins and outs of geophysics, especially in the area of making gravity maps. "It was fun and completely different from the Air Force, in other words a good vacation.

"I have just moved to Eglin Air Force Base in the 'sunny' panhandle of Florida where I am now a flight test engineer flying the Air Force's F-16 and F-15 fighter airplanes. Over the course of a week I fly two-to-three times and control one-to-two test missions from the mission control center. Local activities include a lot of water sports—jet skiing, water skiing, hanging out on the beach, etc. So I guess I have a rough life."

Mike has been invited to be the official guest speaker at a Dining Out (official Air Force dinner) on the *Queen Mary* at the Los Angeles Air Force Base (where Mike used to be stationed). "Wow, my first speaking engagement...."

Eric Tang, who is working at Parallan, reports that he has been surviving the latest wave of layoffs there. "It's just me and my boss in hardware now (makes the group meetings kinda simple!). I'll be OK for a few months, at least until I get my project completed. Lots of opportunities since I'm it! It'll be interesting to see how things progress," Eric writes.

After some months of uncertainty, Julie and **Tom Farkas** have moved to Cleveland, Ohio, where Tom is now working at General Electric Lighting. "I'm working on electronics for electrodeless fluorescent lamps, in which the gas is excited by a coil driven at radio frequencies. It's pretty neat stuff, but I still have a lot of getting-up-to-speed to do." Tom writes that Julie is teaching high school Latin in a sort of honors program for the Cleveland Public Schools. "Her students are mostly good and motivated; nonetheless, teaching in an inner-city public school is an interesting new challenge for her. We're now closer and more convenient to the city (albeit a smaller city) than we were in Ossining. The scenery is not as nice as northern Westchester, but pretty nice considering how close we are to the city. We're also appreciating the flatter terrain, especially when biking. We can actually use our 3-speed tandem bicycle here."

Ed Kim has been in London since the beginning of August. "So far, everything's brilliant—no complaints," Ed writes. "I'm thoroughly enjoying this city, and I'm looking forward to exploring this island and the continent. I'm still with Lehman Brothers, but in a slightly different role. I've spent the bulk of the past two years for Lehman in New York as a proprietary and institutional equity trader on the international desk. I'm now head of non-dollar equity sales/trading for Lehman's high-net-worth-individual group, or Financial Services Division, as it's called. I don't know how long I'll be here, but it will be at least three years."

Michael Berube is still working on environmental policy for Chrysler and enjoying the experience. Michael and his wife, Michele, have a place in Birmingham, Mich.

K. Tibor Toth graduated in June from Northwestern University's joint degree program with the Kellogg School of Management and the McCormick School of Engineering with a master's of management in manufacturing degree. Tibor, his wife, Jennifer, and 1-year-old son, Alexander (born August 10, 1993), just moved back from Evanston, Ill., and bought a house in Framingham, Mass.

Tibor has started a new job working as the VP for a small private equity investment firm called Lee Capital Holdings here in Boston. "We specialize in sponsoring management-led buyouts of small to medium-sized private companies or divisions of public companies. We are very involved in the operations of the companies we control and are always on the lookout for new opportunities, generally companies with $20 to $200 million in sales," he writes. Tibor encourages people to look him up "now that I am back in town!" If anyone has any of those $20 to $200 million companies yet, let Tibor know and he can take a look at them.

Chris Carone is at Lawrence Berkeley Labs for the next three years. . . . **Edwin Marin** is now working at the MIT Lincoln Laboratory. . . . **John Martin** missed Friday night's activities of the reunion because Continental Airlines left him in Cleveland in a stopover without a plane. John is currently at Kellogg (Northwestern) with about eight other MIT alumni/ae, getting an MBA.

"Seems like hell has frozen over...I'm engaged," writes **Cristina Vilella**. Cristina and Tim Zadzora (Lehigh '89) met while she was assigned at Wright-Patterson AFB completing a master's at AFIT. "We are currently planning to get married in Puerto Rico around May or June of next year. Graduation for me is in late September (I haven't done anything since I completed my thesis in July...free time is a wonderful thing!). I'll be taking a short vacation in P.R. with Tim after graduation and will then move to Scott AFB, Ill. Reportedly there is nothing but cornfields in that area, so if any MITers stop in the vicinity of St. Louis, look me up!!"

As for me, I went out to a conference at Stanford University this past August, and ran into a bunch of MIT folk, including **Jason Nieh** who was also at the conference, and **Salma Saeed** who happened to be driving around campus. Both Jason and Salma are attending Stanford. I visited with **Suzanne (Driscoll) Plump** and Andy Plump, '87, who moved into a new place in San Carlos, Calif., on August 1. Suzanne and Andy also got a pair of kittens, which they named Javert and Valjean. Andy and I were standing out on their balcony when, on the next balcony over, appeared **Barak Yedidia** and his wife, Valerie. Barak and Valerie had moved in the same weekend as Suzanne and Andy. Barak and Valerie recently attended a ballroom dance competition held in Lowell, Mass.

Well, that's it again for this month. Thanks, and please send photos for next year's calendar (we'll even accept GIF or any electronic file format for photos)!—**Henry Houh**, secretary, 4 Ames St., Cambridge, MA 02142; phone: (617) 225-6680, fax: (617) 253-2673; e-mail: <hhh@mit.edu> or <henry_houh@mit.edu>, World Wide Web URL: <http://tns-www.lcs.mit.edu/mit89/>

90 5th Reunion

Special thanks to **Toby Sanders** for sending in lots of great information about Class of 1990 alums as well as alums from other years (mostly Bakerites, it seems!) which has been routed to their individual classes.

Toby is happily living in New York City. When not traveling, she works as an education and technology consultant to schools and educational software publishers. She is living with her sister, Wendy Sanders, '93, who is a software producer for the Children's Television Workshop. Toby recently traveled around the Greek Islands with **Chris Bogan.** Chris traveled to Holland and Greece for his job at Tritech—rough job! Also part of Toby's summer travels were stops in London, San Francisco, and Boston. Many of the people Toby saw are mentioned below.

Laura Fleming is working for Motorola where she gets paid to travel and take advantage of those complimentary drinks on airplanes. She recently bought a house in Sunnyvale, Calif., where she is the landlord to **Julie Wissink** and her husband, Sayan Chakraborty, '89. Julie is a fourth-year medical student at Stanford doing her rotations and playing as much volleyball as possible. Sayan is working at Trimble Navigation. They are planning a big trip to India this January.

Lynn Chewning Pekmezian and her husband, Dean, have just moved to Atlanta. Dean will be working as a financial analyst for Hewlett Packard and Lynn hopes to get a master's degree from Georgia Tech. . . . **Greg Gould** is still working at Goldman Sachs where he has managed to climb the ranks without having to go to business school. He was recently promoted to associate in equity research. To celebrate, he went to party and worship the sun in Greece for two weeks. . . . **Feroze Deen** just quit his job to travel the world for a year. If everything goes as planned he will have lots of visitors in India around New Year's and be back in the United States in August 1995 for business school. . . . **Desmond Davis** is going to the University of Texas for an MBA while working for McKinsey & Co. as an "independent" employee. He's living midway between Austin and Houston so he can enjoy the best of both worlds.

Katherine Williams Derbyshire is now senior technical editor of the journal, *Solid State Technology,* published by the PennWell Publishing Co. in Nashua, N.H. . . . **Scott Stevens** is now at Peterson AFB, near Colorado Springs, Colo. . . . **Andrew J. Feltman** has recently transferred to Andrews Air Force Base, Md. He works at the Air Force Flight Standards Agency, which is best described as the Air Force equivalent of the FAA. His work involves ground-to-air radio systems evaluation with the aim of improving the ability of

ClassNotes

planes to talk to the ground. In November, Andrew was promoted to the rank of captain. Backtracking a little, after our graduation in 1990, Andrew worked for Smith & Harroff, a political consulting/PR firm in Alexandria, Va., while waiting for the Air Force to assign him to active duty. Then he spent four months at Keesler AFB at Air Force communications school—the best part of which, Andrew says, is that Keesler is located halfway between New Orleans and Pensacola. Then he spent almost three years at Tinker AFB working with telephone systems design and engineering. The biggest perk of the job was the frequent travel. He had the opportunity to be at Cape Canaveral during the Space Shuttle Columbia launch in September 1991 and also to travel to Thailand.

Send in a note about what you've been up to! Also, let me know if you are interested in any way with helping with our five-year reunion. Thanks! Write to me at my new address or call.—**Ning Peng,** secretary, 732 Bounty Drive #3215, Foster City, CA 94404, (415) 578-0704

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Seymour Liao completed a master's in structural engineering at Stanford and is now working at the Los Angeles office of Ove Arup & Partners, a British architectural engineering firm.

Melissa Schulz (BU '92) and **Peter Stewart** were married just blocks from her grandparents' home in Park Slope, Brooklyn, N.Y., on a beautiful day last August. (See photo for MIT alumni/ae in attendance.) The couple honeymooned in southern Europe and live in New York City, where Melissa is an account executive at Jordan McGrath Case & Taylor, an advertising agency, and Pete is an attorney with Skadden, Arps, Slate, Meagher & Flom, a law firm. Included among the many guests was **Praveen Saxena,** who works with municipal bonds at Prudential Bache Securities.

Please send news to: **Andrew Strehle,** secretary, 59 Commonwealth Ave., Apt. 4R, Boston, MA 02116, or call (617) 450-0637. Send e-mail to: **Renee Miller**: <miller-rl@post7.laafb.af.mil>

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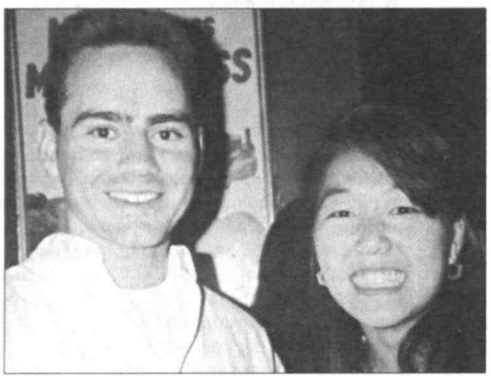
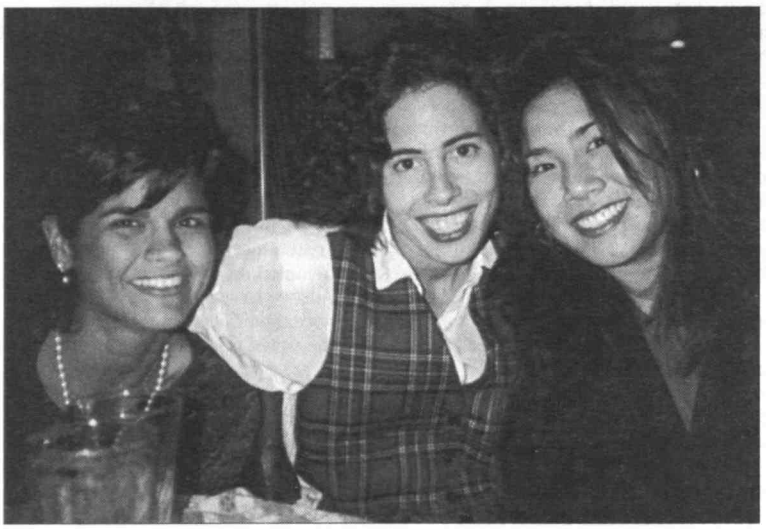
First I want to apologize for my missing column in the November/December issue. Lots of news this month to make up for it. I received a wonderful letter from a fellow architecture friend, **Austin Sloat.** Austin is getting an MArch at University of Hawaii and also working full-time for an architect, or as much as possible while he's in school. There are only about 15 students in the MArch program there. This is Austin's last year and he is busy refining his abilities in certain areas (especially third world development), so he may design superior grass huts one of these days. His boss, who is extremely cool, does mostly residential work and leaves Austin, his sole employee, in charge of much of the business. Austin says that he is getting great experience. "It is the kind of job that I dreamed of. It pays well, and the only office rule we have is no beer before 3:30. I can live with that." Seeing as Hawaii is beautiful and the ocean is stunning, Austin has been trying to get a lot of scuba diving in between architecture projects, like building a house in Oregon this past summer. Last winter Austin went to California and saw **Paul Tompkins** in LA where Paul works for Hughes. Then, he went to San Francisco and hung out with **Andy Liu, Stacey Au, Franz Lutz** and his girlfriend, Grace Aranda, and **Jessica Im** and her husband, John Sadier '86. They spent the weekend at Austin's boss' house in Napa Valley, went to a bunch of wineries and had a blast. Thanks for all the news!

Suzanne Garber sent me an awesome letter, too, from slightly farther north. She has been working for Microcosm in Torrance, Calif., since last March. She and **Newton Agrawal** have been involved with the MIT Alumni/ae Club of Southern California, and she is now VP of young alums. . . . **Beth Kader** and **Patrick Cazeau** both completed master's degrees in aero/astro this past spring, Beth at Stanford and Pat at MIT. Pat worked as a consultant for the Mide Technology Corp. this summer, and now he and Beth are both working for Hughes and living with **Paul Tompkins** in Hermosa Beach. . . . **Johan Denecke,** who recently finished a master's at MIT, is also in Manhattan Beach and working for Hughes. . . . **Jon Strizzi,** who was in D.C. for a year, is now back in Suzanne's neck of the woods for the four years he promised to the Air Force. Suzanne still hangs out with **Scot Cook** in Manhattan Beach. Scot has been working for TRW since 1993. . . . **Dave Vetter** was hanging out in Manhattan Beach this past year, too.

Moving a little further east for news, **Dave Towner** writes, "I've recently relocated to Tempe, Ariz., to be with my fiancée, Katherine Oldham, '94. I'm an unemployed technical writer, hoping to be an employed one in the near future." Previous to his move, Dave was living in Somerville with **Joe Padanilam** and working in Cabot Science Library at Harvard. With the help of the current Bombers, Dave planned the Burton Third Bombers 25th Patriot's Day celebration this past spring with over 100 alums coming from as far as Japan to attend. Dave has taken up running marathons, running three this past year including Boston and San Francisco. In all three races, he was joined by Mike Geer, '89, who's still finishing up a doctorate in civil engineering at MIT. They both hope to qualify as official runners

CLASS OF 1991: The Stewart/Schulz wedding in Brooklyn last August included the following MIT friends—Kneeling (from left): Robert Xavier, '89, and Andrew Liu, '92. Standing in first row: Peter Stewart, '91 and his wife, Melissa Schulz Stewart; Andrew Karduna, '89, Paul Antico, '91, Praveen Saxena, '91, and Erich Burton, '89. Standing in second row: Jon Goetz, '92; Ed Reiskin, '88 (forehead showing); Larry Yu, '89; Andrew Strehle, '91; Jimmy Kunihiro, '88; and Marcus Babzien, '90.





'92ers (& a '94er) in NYC: Above, Jeff Jacobson and Chrissy Kwon take a break from medical studies. Right, Roopa Mehendale, Leslie Barnett, and Lillian Kuo, '94, enjoy a tête-à-tête-à-tête.

in the 100th Boston coming up in 1996. Dave is getting married in July 1995 in Berkeley, Calif., and expects loads of MITers to be in attendance. Congratulations and thanks for the news!

From the old homestead of Cambridge, **Russ Cohn** also sends news via personal letter. He is working for Gemini Consulting and tells me that **Jesse Goranson** is working for Gemini in London along with some other MIT alums. Russ saw **Joanne Guttierrez** and **Kiet Van** in Arizona this past year. This past summer Russ did a lot of sailing and bought a windsurfer—cool! And he's been watching Horst Govin, '91, and his band *Famous People* play around Boston. Russ says they're really good and anyone in town should see them jam. He is still hangin' out with **Mark Duggan** who hasn't had enough of school yet and this fall started the PhD program in economics at Harvard. I guess that would explain why Mark is too busy to let some of his friends know his exact whereabouts.

Well, I'm finally out of the mountains and back on the island—Long Island. Before I left Aspen though, I bumped into Mike Powers, '91, and his girlfriend, Pablo Munguia, '91, and his girlfriend, Kurt Russell and his girlfriend (Goldie Hawn), Dick Van Patten, Barbie Benton, and Arnold Schwarzenegger (who looked surprisingly small in person). Keep on writing.—**Leslie Barnett,** secretary, 56 Brown St., Mineola, NY 11501, (516) 746-4291

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Happy New Year! Can you believe it's 1995 already? Nearly two years since we graduated! I wish all of you a successful 1995 and lots of news worthy of printing in Class Notes. This month I'd like to hear from: **Maria Kilos, Ken Justin, Greg Best,** and **Amy Chiang.**

Malcolm Stevens is starting his second year in graduate school for architecture. When he is not in class, he works periodically for Cambridge Seven Associates and lives with Abigail Schoolman (Wellesley, '93). . . . **Katherine Trauth** recently received a master's from MIT and received a commission as a Navy ensign. . . . I run into **Martha Bulyk** periodically on the bus. She is in her second year at Harvard working towards a PhD in the Biophysics Department. In addition to doing research in a crystallography lab, she is a T.A. for an intro biology class at Harvard. She is living with Ellen Gonzales, '94, Amy Bany, '94, and Michelle Starz, '94. Martha's boyfriend, **James Sarvis,** is still at MIT where he is finishing up a master's in computer science after receiving a double degree in mathematics and computer science. He is planning to stay on for a PhD. James' roommates are **Keith Randall,** who is in his second year of a PhD program at MIT, and Andrew Kirmse, '94.

Recently married are **Kate Bergeronz** and Mike Gull, '92. The wedding took place in North Conway in the White Mountains. They held their reception on the side of a mountain. I am told that it was quite beautiful. Also in the wedding party were **Andrea Wang** and Albert Cheng, '92. Kate is in school at University of Colorado at Boulder. . . . In October, **Myev Fogerty** was married to Eric Bodenhofer from Boston College. Both Myev and Eric are working in the Boston area.

Kristine Yoder moved to San Francisco several months ago and reportedly is working at UC/SF as a technician. . . . **Ruth Hwang** is working for Oracle and should be coming to MIT to interview for a position as an Educational Counselor, who does admissions interviews for MIT.

On the medical front, **Leila Tabibian** is at USC School of Medicine. **Karen Oda** is attending UCLA School of Medicine. **Cherry Wongtrokol** is in her second year at Cornell University Medical School. Both **Susan Choe** and **Shula Lerner** are at Albert Einstein Medical School in New York. Also attending medical schools in New York are **Elisabeth Ho, Vinuta Mohan,** and **Gautam Ramakrishna** at Mt. Sinai and **Jane Bae** at NYU School of Medicine.

Many MIT graduates can be found in the financial center of New York as I found out from Class President **Rehsma Patel.** Reshma is in the Department of Public Finance at Prudential Securities with **Lilian Chern. Elizabeth Mennhett** is also at the same company in the Financial Strategy Group. **Amy Chiang** is working for Citibank, as is **Pashun Patel,** who just finished a master's in Course VI-A from MIT. **Jackson Lum** is at Bear Sterns. He lives with **Danny Grana** who works for Merrill Lynch. **Sing-ming Law, Paul Mangione,** and **Zahra Kherani** are all working at First Boston. **Neal Mitra** and **Oliver Chow** are at Monitor. Neal is in management consulting. He recently received a master's in mechanical engineering from MIT.

On April 17th, **Erik Tavzel** was married to **Keri Kreitner** in Annapolis, Md. **Mike Liu** was the best man. Also in attendance were **Aaron Barr, Mike Dumbroski, Hany Michail, Steve Wisloski, Tomjay Paul, Horace Kelly, Rob Zgonena** and **Andrew McFarland.** Erik is working in the financial district in Boston. Andrew writes that Horace, Mike Liu, Mike Dumbroski, and Steve are all working in the Boston area as is **Sean Hogarty.** Sean graduated in May. Hany Michail started medical school in New Jersey. Tomjay, Rob, and Aaron are all working hard on Wall Street. Andrew is in his second year at MIT working on a master's in aero and astro. Once he has finished the master's, he plans to be off to the Navy's Flight School in Pensacola, Fla., where he "will (hopefully) learn how to fly the newest and best jets in the Navy."

Andrew McFarland also traveled to the wedding of **Tim Wilson** and **Julie Lyren** in Akron, Ohio. Tim and Julie are now living in Austin, Texas, where "to their surprise, (they) are both pursuing careers in their respective majors, architecture and materials science."

That's all for now. Make sure to get in touch with the people named at the start of the letter. If you want to get on the MIT Class of 1993 mailing list, you can subscribe by sending mail to <listerv@mitvma.mit.edu>. In the e-mail write: SUBSCRIBE MIT1993. Make sure there is a space between "subscribe" and "MIT1993." Of course I can always be reached by mail. Hope to hear from you soon.—**Mavi Madsen,** secretary, 12-16 Ellery St., #405, Cambridge, MA 02138

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Please send your news for this column to: **Walt Babiec,** president, c/o Aerospace Corp., Box 92957, Mail Stop M4/922, Los Angeles, CA 90009

CourseNews

I CIVIL AND ENVIRONMENTAL ENGINEERING

Abi O. Aghayere, SM '83, writes: "I am a project structural engineer with Halsaii Associates, Ltd., in Toronto, Ontario. We are working on the design of building structures. Recent project credits include the $100 million federal virology lab in Winnipeg, Canada. I'm also involved in the development of in-house analysis/design software."... **James V. Hamel**, SM '66, reports: "Hamel Geotechnical Consultants in Monroeville, Pa., is extremely busy on numerous dam, landslide, infrastructure, and environmental projects throughout Pennsylvania. I am heavily involved in rock slope evaluations, including risk analyses for the Pittsburgh Airport Busway."... From Willimantic, Conn., **John N. Ivan**, SM '87, sends word: "I completed a PhD in civil engineering at Northwestern University in May 1994, and have been appointed assistant professor of civil engineering at the University of Connecticut at Storrs. I am teaching and conducting research in the area of transportation systems planning and operations."... **Jonathan Richmond**, SM '81, PhD '91, sends e-mail: "For those of you who don't yet know, I'm pleased to announce that I have been appointed to a faculty position in the Economics Department of the University of Reading in England."...

Michael S. Schultz, SM '81, has been named an associate at Camp Dresser & McGee, Inc., in Cambridge. He was previously manager/principal in charge of engineering at Dames and Moore, Inc., in Boston.... Professor **Charles C. Ladd**, '55, SM '57, ScD '61, has been selected to hold the second Edmund K. Turner Chair in the Department of Civil and Environmental Engineering. The Turner Chair is an endowed chair established in 1915 by Edmund K. Turner, class of 1870.... **Heidi Nepf**, also a Course I professor, has been selected to be part of the National Mentoring Program sponsored by the National Women's Economic Alliance. Six women are selected from the fields of education (Nepf), law, medicine, journalism, business, and art.... The Society for Experimental Mechanics (SEM) conducted an international student paper competition at the 1994 SEM Spring Conference held in Baltimore, Md., last June. MIT graduate student **Hong C. Rhim** won one of three awards given by SEM in this competition for his work and presentation on "Radar Imaging of Concrete for Nondestructive Testing." His paper will appear in a special issue of *Experimental Technique*, a bimonthly magazine published by SEM.

The Association of Alumni and Alumnae have been notified of the following deaths: Colonel **Samuel Nairn Karrick, Jr.**, '48, of Arlington, Va., on April 23, 1994, and **Daniel Beltran-Maldonado**, SM '62, ScD '65, of Bosques De Las Lomas, Mexico, on April 11, 1994. No further information was provided.

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>.**

II MECHANICAL ENGINEERING

Bruce D. Gavril, SM '49, ME '51, ScD '54, sends a fax: "I retired from IBM on May 31, 1993, after an association spanning 29 years. In my last position, as a senior engineer at the Thomas J. Watson Research Center, I wrote the two invention disclosures for the inter-nodal communication architecture used in IBM's first massively parallel processing system, the IBM 9076 SP1, announced in March, 1993. Both of these disclosures resulted in patent applications—one disclosure being filed as written. I continue to live in Chappaqua, N.Y., with my wife, Jean Van Leeuwen, a writer of books for children. We have two children—Elizabeth, a senior at the University of Rochester, and David, who recently graduated from Hampshire College.... **Robert W. McCarthy**, SM '85 (II, XIII), writes: "I was promoted to commander, U.S. Coast Guard, in July 1994. I am currently serving as the Coast Guard attaché and police attaché at the U.S. Embassy in Bogotá, Colombia."... From Pleasanton, Calif., **Mat Waltrip**, SM '89 (II, XXII), reports: "I am now coordinator for the NUHOMS Owners Group, composed of our utility clients and international licensees who are actively involved in using the company's system for storage and transportation of spent nuclear fuel. My company, Vectra, is pursuing a contract to design and license the multi-purpose canister (MPC) for the Department of Energy. My wife and I just purchased our first home."

Robert A. Sutton, 'SM '72, sends word: "After many years at various Caterpillar plants in the Midwest, the Sutton family moved to a start-up facility at Clayton, N.C. in June 1992. This facility is the headquarters for the Building Construction Products Division, which also includes the facility at Leicester, U.K. We are responsible for the smallest machines in the Caterpillar product line. As director of engineering, it is challenging to stay abreast of work on everything from small track-type tractors built in Japan to wheeled excavators designed and built in Germany. The family has adjusted to North Carolina and the Raleigh area. They are quite tolerant of transplanted Yankees."... **Ronald E. Smelser**, SM '72, writes: "I was appointed associate professor of mechanical engineering at the University of Idaho Engineering Education in Boise after 10 years at Alcoa Technical Center in Pittsburgh and one year at Concurrent Technologies Corp. in Johnstown, Pa.... From Santa Barbara, Calif., **Charles R. Dodson**, SM '32, reports: "I was awarded the Centennial Medal by the College of Engineering at the University of Maryland in College Park, for a distinguished engineering career by the Engineering Graduate School last May."... .**Rebecca Thatcher Ellis**, SM '87, sends news: "I am among the founders of Sebesta Blomberg & Associates, Inc., a new mechanical/electrical consulting engineering firm in Minneapolis. SB&A will provide M/E engineering services to institutions, industry, government, and utilities; developing optimized solutions in the areas of power generation, central heating and cooling facilities, building energy systems, process and environmental controls, systems commissioning, and energy conservation."

Capers McDonald, SM '76, reports: "In December, 1993, I was part of a group that founded Magenta Corp., which provides contract production services for clients engaged in gene therapies. Early in 1994, Magenta formed a wholly owned subsidiary with production facilities in Stirling, Scotland, to better serve European clients. I am president and CEO of Magenta Corp. and chair of the U.K. subsidiary. I remain CEO of Microbiological

DEGREE CODES

AE	Aeronautical Engineer
BE	Building Engineer
CE	Civil Engineer
CHE	Chemical Engineer
CSE	Computer Science Engineer
DPH	Doctor of Public Health
EAA	Aeronautical & Astronautical Engineer
EE	Electrical Engineer
EGD	Doctor of Engineering
ENE	Environmental Engineer
MAA	Master in Architecture Advanced Studies
MAE	Materials Engineer
MAR	Master in Architecture
MCP	Master in City Planning
ME	Mechanical Engineer
MET	Meteorologist
MIE	Mineral Engineer
MME	Marine Mechanical Engineer
MNG	Master in Engineering
MPH	Master in Public Health
MTE	Metallurgical Engineer
NA	Naval Architect
NE	Naval Engineer
NUE	Nuclear Engineer
OCE	Ocean Engineer
PhD	Doctor in Philosophy
ScD	Doctor of Science
SE	Sanitary Engineer
SM	Master of Science

Associates, located in Rockville, Md.". . . From Homosassa, Fla., **Robert L. Hall**, '46, writes: "Tennis, golf, radio control model a/c, personal computer, yard maintenance, dishes, beds, and monthly contributions to my doctor's well-being.". . . **Ashok B. Boghani**, '73, SM '71, ScD '74, sends a brief note from Acton, Mass.: "In December 1993, I was elected a corporate VP of Arthur D. Little, Inc.". . . **Nicholas R. Tomassetti**, SM '58, has been named president and COO at Airbus Industrie of North America in Herndon, Va. Previously, he was VP and general manager of Twin Jet Business Development at Douglas Aircraft Co. in Long Beach, Calif. . . . **Subramanyam Kumar**, ScD '86, who has worked in air quality research and consulting for 16 years, has been named director of the Air Quality Division at ERM-New England, located in Boston.

Kenji Shimada, PhD '93, married Betticlare Irminger last July 3. Shimada is a researcher at IBM-Japan.

Mark Theobald, ScD '86, of GM's R&D Center, has been named by the SAE as its 1994–95 Fellow at the Department of Commerce's Partnership for a New Generation of Vehicles. Theobald will serve for one year as a Technology Administration Fellow and he will be involved in the day-to-day activities of this new government and industry partnership. The PNGV was established by President Clinton in October 1993, as a cooperative agreement between the DOC and Chrysler, Ford, and GM. The program's long-term goal is the development of a vehicle that will be up to three times more fuel efficient than today's vehicles. The new vehicle must not cost more to own and operate than current cars, should offer comparable characteristics relating to performance, roominess, and utility, and meet or exceed all safety and emission requirements. A research engineer at GM since 1986, Theobald has conducted engine research in variable valve actuation, hydrocarbon emissions mechanisms, and diesel combustion. Before joining GM, he was at the Sloan Engine Laboratory at MIT and an engineering consultant at Bolt Beranek and Newman, Inc

Two Navy updates: Lieutenant Commander **Dennis C. Logan**, SM '91 (II, XIII), recently reported for duty with Commander, Naval Surface Group Mediterranean, in Naples, Italy. Commander **Kevin M. McCoy**, SM '89, NE '89 (XIII), reported for duty aboard the submarine tender USS *L.Y. Spear*, homeported in Norfolk, Va. . . . **Woodie C. Flowers**, SM '68, ME '71, PhD '73, Course II professor of teaching innovation, has been named to the National Academy of Engineering for "contributions to the teaching of mechanical engineering design."

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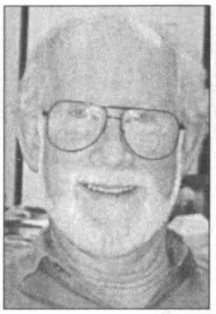
III MATERIALS SCIENCE AND ENGINEERING

From North Caldwell, N.J., **John R. Mihalisin**, ScD '53, writes: "I retired from the Howmet Corp. in 1991, and have remained in a consulting capacity for the corporation since that time.". . . **Stanley I. Warshaw**, ScD '61, was appointed senior policy advisor in the U.S. Department of Commerce in June 1994. . . .



Simon Moss

Simon Moss, '56, SM '59, ScD '63, is the 1994 winner of the Esther Farfel Award, the most prestigious honor that the University of Houston bestows upon its faculty. Moss joined UH in 1972 with the charge to build the program in solid state physics. His pioneering X-ray and neutron scattering studies of disordered and defective solids, contributions to the understanding of crystalline and noncrystalline materials, research on the structure of liquids and amorphous solids including glasses and colloids, and work with high-temperature superconductors, thin films, and Carbon 60 crystals is recognized nationally and internationally. Moss won a Guggenheim fellowship in 1968 and was elected a Fellow of the APS in 1975. In 1990, he received the UH Excellence in Research Award. Within the past year, he won the Max Planck Research Award from Germany's Humboldt Foundation and the David Adler Lectureship Award from the APS. He serves on many NAS and NSF committees and is divisional associate editor for the *Physical Review Letters*, the most prestigious research journal in physics.

Course III Professor **Bernhardt J. Wuensch**, '55, SM '57 (VIII), sent a memo full of news of the annual meeting of the American Ceramic Society (ACS), held in Indianapolis last April. Six Course III alums were elected to Fellowship in the ACS: **Rowland M. Cannon**, '66, ScD '75, staff scientist at the Lawrence Livermore Lab; **David C. Cranmer**, SM '78, PhD '81, associate director for the Manufacturing Extension Partnership at NIST; **Isabel K. Lloyd**, PhD '80, assistant professor in the Materials and Nuclear Engineering Department at the University of Maryland; **Thomas O. Mason**, PhD '77, professor at Northwestern University; **Gerald S. Meiling**, SM '59, ScD '66, VP and director of research at Corning, Inc.; and **George C. Wei**, PhD '76, advanced engineering specialist at Osram Sylvania, Inc. Approximately 30 individuals are elected to Fellowship each year out of a membership of many thousands. This year, MIT alums accounted for 20 percent of the total. The 1994 Ross Coffin Purdy Award given "in recognition of the outstanding contribution to ceramic literature in 1992" was awarded to **I-Wei Chen**, PhD '80, and his doctoral student, **Shih-Yu Liu**, from Course XXII, for their paper "Fatigue Deformation Mechanisms in Zirconia Ceramics." In addition, each year the society awards three memorial lectureships. The Arthur L. Friedberg Memorial Lecture was given to **Richard C. Bradt**, '60, professor of materials science and engineering at the Mackay School of Mines at the University of Nevada at Reno. His presentation was entitled "The Hardness of Ceramics, Glass, and Minerals." The Sosman Memorial Lecture, entitled "Physics of Drying" was presented by **George W. Scherer**, '72, SM '72, PhD '74, of the Central Research Department at E.I. du Pont de Nemours & Co. The Edward Orton, Jr., Memorial Lecture, entitled "Industrial Ecology: A Key to Green Processing and Green Design," was presented by **Robert A. Laudise**, PhD '56, adjunct chemical director at AT&T Bell Labs and adjunct professor at MIT. "The Orton Lecture is one of the highest honors bestowed by the society," wrote Wuensch. "Laudise's talk was superb—the subject timely, the presentation flawless and well-orchestrated, and it had just the right mix of humor to keep people engaged for a full hour."

Charles R. Kurkjian, ScD '55, has been inducted into the NAE for "contributions to the understanding of the strength and fatigue of glass that led to development of long optical fibers." Kurkjian is a member of the technical staff at AT&T Bell Labs in Murray Hill, N.J. . . . **H. Kent Bowen**, PhD '71, Kim B. Clark, Charles A. Holloway, and Steven C. Wheelwright are the editors of *The Perpetual Enterprise Machine* (Oxford University Press, 1994). The book, the product of a collaborative effort between five companies—Chaparral Steel, Digital Equipment Corp., Ford Motor Co., Hewlett-Packard, and Eastman Kodak—and four universities—Harvard, MIT, Purdue, and Stanford—is about the principles that drive outstanding development of new products and processes. It is about the kind of enterprise that will thrive and prosper in the years to come by building and renewing itself as it creates new products and processes.

Stanley Y. Ogawa, 'SM '60, of San Jose, Calif., died on September 24, 1993. Ogawa, who worked for the General Electric Co., retired in 1992. During his almost 40 years at GE, he took two leaves of absence, one to serve during the Korean War from 1955 to 1957 as a heavy-equipment maintenance officer, and the other when he attended MIT. At GE, Ogawa worked primarily on civil nuclear programs, where his contributions to nuclear fuel developments gained international recognition. He joined the SP-100 Space Nuclear Power program. He was active in helping others—in a career awareness program with the Boy Scouts and in a program assisting disadvantaged school children and teenagers. Ogawa was a member of the Santa Clara Valley chapter of the American Society of Metallurgists.

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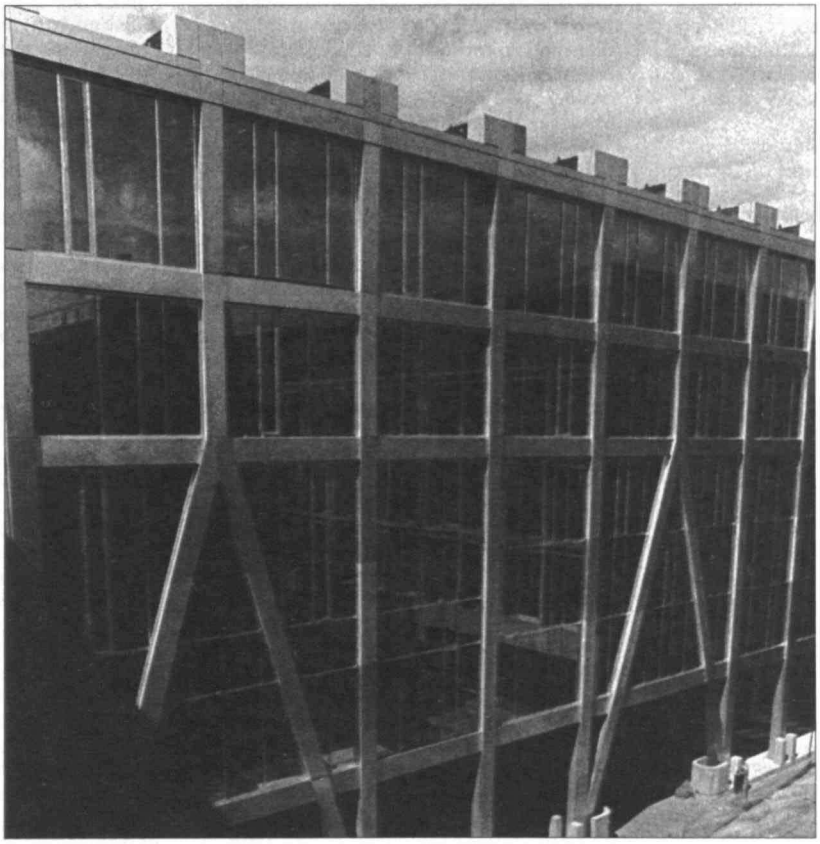
IV ARCHITECTURE

Albert C. Yang, MAA '79, writes: "I've remained in the Boston area since graduation, earning an MSIS at Northeastern University in 1985. I was an associate architect at Eduardo Catalano Architects and Engineers in Cambridge from 197985, in AEC Application Software Engineering with CAD/CAM R&D at Prime Computer from 1985–88, with Computervision from 1988–91, engineering manager and then director of R&D at Sigma Design, Inc., in Burlington, Mass., from 1991–94, and am now VP for product engineering at Sigma." . . . From Lakeland, Fla., **Steven Boyington**, MAR '81, reports: "Over the last 10 years, I have worked in three firms, finally becoming a partner at Regnvalll, Wallis, Boyington three years ago. The eight-member firm's works include historic renovations, the $20-million Lakeland City Hall Complex, an air-bag manufacturing facility, and most recently, a new train station. My other activities include coaching my son and daughter in soccer. We loved

MIT's Rotch Library: A Hidden Treasure

By Robert Campbell



Imagine designinga library to look like a huge glass-fronted bookcase. That is the sweetly witty conceit of architects Warren Schwartz and Robert Silver in their Rotch Library, which houses the architecture collection at MIT.

This week, at a ceremony that included Mayor Menino of Boston, the Rotch was awarded the Parker Medal, which honors "the most beautiful piece of architecture" of the year in greater Boston.

The Rotch is a true gem, although it's a gem whose glitter is destined to go unseen by most of us, since it's tucked away in a dark truck-delivery courtyard in back of MIT's main building. Perhaps the poet Thomas Gray was prophesying this building when he wrote:

Full many a gem of purest ray serene,

The dark unfathom'd caves of ocean bear.

I hesitate to recommend to anyone the psychic trauma of trying to find anything at MIT, but for the dedicated archibuff the hunt for the Rotch is worth the pain. This is an amazing building. Six stories of book stacks are suspended on steel straps from rooftop beams, so as to allow uncluttered space beneath the library for the trucks to maneuver. It's a dazzling display of structural inventiveness and, as such, it's a visual lesson for the students of the school of architecture it serves. (Simpson Gumpertz & Heger were structural consultants.)

Equally ingenious is the bookcase metaphor. It's a trick of scale. You can't help reading the six levels as six huge shelves, and the vertical stacks inside them as huge individual books. I'm not sure how conscious the architects were of this Alice-in-Wonderland visual pun, but it's unmistakable.

The bookcase metaphor endows the Rotch with the kind of wit and cultural reference so often sought by the so-called postmodern style of architecture. The Rotch itself is uncompromisingly modern, as befits a no-nonsense institute of technology. It doesn't offer the least hint of ornament, nor does it seek to charm you by tweaking your memories of architecture past. Yet it's so boldly imagined that it fires your own imagination in response. You can see it not only as a bookcase, but as a bold steel-trussed bridge, or as a glass museum vitrine for the display of a precious collection, or as the cage in a zoo behind which must lurk some exotic presence.

Indoors, the library works well. It's clipped on to the original MIT building like a saddlebag. The architects leave a five-foot, six-story slot of space between new and old, both to express the difference and to create a skylit lightwell. They're careful to relieve the rigor of their structural conception with enough oddity and playfulness, for instance in a freely shaped, oddly angled reception desk.

Prizes come and go, and in architecture there are far too many of them. But the Parker Medal, after 70 years, is one that keeps gaining significance. It's been around so long now that it has become an invaluable index of the history of taste in Boston. The Rotch is a worthy addition to its long roster. □

This article first appeared in the Architecture column of the Boston Globe *on July 22, 1994. It is reprinted here with the Globe's permission.*

PHOTO: DONNA COVENEY/MIT NEWS OFFICE

those World Cup Games last summer!"... **Bharat Gami**, MAA '79, sends word: "My firm, Gami and Associates, P.C., Architects, has been involved in the following New Jersey projects: an addition to the town hall in Kearny, a shelter for the homeless in Jersey City, and a child-care center in North Bergen."

From Irving, Tex., **Robert S. Allan**, MAR '55, reports: "My company, Robert S. Allan & Associates, Inc., is now in its 26th year of successful operation. Our current work combines new techniques in meeting today's social needs with great flexibility for future changes. Correspondence with class members is welcome, fax: (214) 637-3380." ... **Jeff Schoellkopf**, MAR '84, writes: "I am continuing to work as an associate in the Edgcomb Design Group of Warren, Vt., with **Jim Edgcomb**, MAR '84. I recently taught an undergraduate architecture studio at Norwich University in Northfield, Vt. I am currently working on a variety of small commercial, planning, and residential projects in four states. I also teach periodically at the Yestermorrow School in Waitsfield, Vt., lecturing in environmentally sensitive design, teaching home owners design and building skills, and teaching architecture students construction skills. Finally, I edited the Yestermorrow Newsletter this year on 'sustainable design'."

Peter Conant, MAR '73, sends word: "I am president of CMA Architects, Inc., in Jamaica Plain, Mass. Recently completed construction of two 25-unit single-family sub-divisions of affordable housing, developed under Massachusetts 'Comprehensive Permit' (Chapter 774 of MGL), for the towns of Bolton and Stow, Mass. The developments are a mix of market-rate and subsidized homes sold to first-time buyers who meet certain income guidelines. CMA Architects, Inc., acts as the developer, architect, and contractor for the projects, and recently received approval for a 40-unit development of affordable houses in the town of Bedford, Mass. Comprehensive permits allow a developer to increase density in exchange for affordable pricing. Many towns with minimum lot sizes of an acre or more have made it difficult for first-time buyers to afford a home." ... From Winchester, Mass., **Mary McKenna**, MAR '83, writes: "In 1989 I founded Mary McKenna and Associates, Architects. I was recently chosen as the architect to renovate the United South-End Settlements Children's Art Center in Boston. This center has provided after-school art and music instruction for neighborhood children free of charge since its establishment in 1918 by the generosity of Miss Annie Endicott Nourse and Mrs. Mary C. Wheelwright. I'll be designing a new addition, which will include ADA toilets and entry ramp, storage, and kiln area, along with providing a feasibility study for the restoration of this Italianate-style building and its gardens.

By way of e-mail, **Murat Germen**, MAR '92, writes: "After graduation from MIT, I worked in Tucson, Ariz., for a year as a Fulbright intern. I then returned to my home, Turkey, and worked as an instructor in a university. I receive *Technology Review* and find that I am not so isolated from MIT's [rich multicultural] environment. This past year I worked at Bilkent University, a private university in Ankara. I worked in the School of Fine Arts, Design, and Architecture in the Department of Interior Architecture. While there I taught basic design studios and two computer/math classes. I've decided to leave the academic environment to pursue my professional practice of architecture. I am working in a small but industrious and creative three-person office. We design structural and architectural systems internationally—not because these systems are not available in foreign countries, but because the production costs are much less in Turkey."

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V CHEMISTRY

Julio Arrecis, PhD '92, writes: "I am a senior chemist with the Florida Department of Environmental Protection in Tallahassee. My research efforts are focused on understanding mercury build-up in the Florida Everglades and detecting sub-part-per-trillion mercury species. I have been on the staff for two years."... **Richard A. Johnson**, PhD '71, reports: "I've been working for the U.S. Department of Energy in Morgantown, W.Va., since 1988. I'm currently serving as project manager for design and construction of a $30-million facility for development of advanced coal gasification technology.... **Charles H. Beede, Jr.**, PhD '62, sends word from Arlington, Tex., that he has retired from Johnson & Johnson Medical, Inc. ... From Watertown, Mass., **Curtis E. Adams**, PhD '85, writes: "**Toni Chancellor-Adams**, PhD '83, and I have relocated to the Boston area. I am a member of the technical staff at Cabot Corp. in Billerica, and Toni is a principal investigator at Procept, Inc., in Cambridge.... **Joseph Irgon**, PhD '48, sends word from Flanders, N.J. "Alumni of CWSDLMIT (Chemical Warfare Service Development Laboratory at MIT, 1942–45) with whom I've had contact include Charlie H. King, Jr., '41 (X), **Art R. Olson**, '39, Otto Morningstar, PhD '39 (VIII), **Charlie W. Sauer**, '41, PhD '49, '62 (XV), Willard J. Slagle, '29, SM '29 (XV), and Bob Van Tuyle, '42 (X). Not all are retired, I am pleased to report."

John A. Latham, Jr., PhD '85, has been named director of chemistry at Darwin Molecular Corp. in Bothell, Wash. He was previously at Gilead Sciences, Inc., in Foster City, Calif.... Navy Ensign **Thomas J. Allen**, PhD '93, recently completed Officer Indoctrination School in Newport, R.I. While there he was prepared for duty in the naval staff field corresponding to his civilian profession.... **Thomas F. Schatzki**, PhD '54, has won one of the highest annual awards given by the Agricultural Research Service (ARS) for transferring new technology to the marketplace. Schatzki, who has worked at the ARS's Western Regional Research Center in Albany, Calif., since 1972, applied X-ray technology to speed detection of prohibited foods and other agricultural contraband in luggage at airports. These outlawed goods may carry pests such as Mediterranean fruit flies. ARS is the chief scientific agency of the U.S. Department of Agriculture. USDA's Animal and Plant Health Inspection Service, responsible for keeping exotic pests out of the U.S., has installed 75 X-ray machines in U.S. airports. Schatzki's tests at the Los Angeles International Airport in 1989 showed that X-ray viewing of luggage detects four times as much contraband as random manual searches. He received a plaque and a cash award.

The Association of Alumni and Alumnae has been notified that **George A. Divers III**, SM '76, died in September 1993. No further information was provided.

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>.**

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

From Latham, N.Y., **James M. Tien**, SM '67, EE '70, PhD '72, sends word: "After serving for two years as acting dean of engineering at Rensselaer Polytechnic Institute, I resumed my position as chair of the Department of Decision Sciences and Engineering Systems (DSES). DSES is a unique interschool department, reporting to the Schools of Engineering, Management, and Science."... **Walter Hamscher**, SM '83, PhD '88, reports from Half Moon Bay, Calif.: "I am the director of R&D at the Price Waterhouse Technology Centre in Menlo Park, Calif. Our group is involved in several advanced technologies including hypertext, multimedia, and artificial intelligence."... From Powell, Ohio, **William L. Adams**, SM '56, writes: "I returned from a three-year tour in Moscow with ABB and retired. I'm consulting on strategic planning and trade with Russia."... **Wilbur L. Pritchard**, EE '52, sends news: "I am president of W.L. Pritchard & Co., Inc., in Bethesda, Md. We are consulting engineers in satellite communication."... **Ralph T. Soule**, SM '91 (VI, XXII), sends an e-mail update: "I am currently assigned to the Puget Sound Naval Shipyard in Bremerton, Wash. I am responsible for the completion of nuclear repair work on the USS *Nimitz* (CVN 68), which is in the shipyard for a 12-month maintenance period. In one year, it will require over 300,000 man-days of work. Thus far it is right on schedule."

From Ocean Grove, N.J., **Edwin Z. Gabriel**, EE '51, updates us on his patents: "I received U.S. patent no. 5,299,845, on April 5, 1994, entitled "Automatically Actuated Cargo-Hook Device and manual guidance system for suspended loads." The device consists of tongs-like jaws that are lowered by hoist cables to a load. The device includes a suspended magnet from its pivot hub to attract and grip the load cable; no personnel are required at the pick-up site to hook the cable. When the hoist cable is pulled from above, the hook's jaws automatically grab the cable, with positive load retention. Another patent, a cargo and personnel scooping apparatus, snatches the entire load. Additional automatic features are being added to this patent in a pending patent."... **Gordon K. Harris, Jr.**, SM '66, writes: "I am a partner at Harness, Dickey & Pierce in Tory, Mich. The firm specializes in patent, trademark, and copyright law. I received a J.D. in December 1977 at Ohio State University."... From Sunriver, Ore., **Wilbur B. Davenport, Jr.**, SM '43, ScD '50, sends word: "I retired for the third time in May 1993 and then wrote up my lecture notes for an undergraduate course on statistical communications theory. I'm hoping that some publisher will be interested. Since August, I have been a trustee of the Sunriver Preparatory School."... **Wesley Pendleton**, SM '40, reports: "Last July 1st we observed our 55th wedding anniversary by going north to Canadian Sault Ste. Marie and took the Agoma rail trip to the Agawana Canyon in Ontario. This was a day-long ride

with box lunches in the canyon where we saw three water falls. On July 20th, we went to Harrison, Mich., to a reunion of our Florida mobile-home-park people. Nearly 200 of the 600 folks were in attendance."

Six Course VI alums were inducted into the National Academy of Engineering last October. They are: **Marshall L. Fisher**, '65, SM '69, PhD '70, the Heyman Professor of Operations Management at the University of Pennslyvania, for "advances in solving large-scale engineering problems in vehicle routing and logistics"; **Paul G. Kaminski**, SM '66 (VI, XVI), chairman and CEO at Technology Strategies and Alliances, in Burke, Va., for "leadership and technical contributions to stealth technology and military systems"; and **John G. Kassakian**, '65, SM '67, EE '67, ScD '73, Course VI professor and director of the Laboratory for Electromagnetic and Electronic Systems at MIT, for "contributions to research, education, and industrial alliances in power electronics." Also, **Paul L. Penfield, Jr.**, ScD '60, Course VI department head at MIT, for "contributions to very large scale integration (VLSI) simulation and to the theory of active networks and for leadership in engineering education and microstructures research"; **Robert A. Pucel**, '50, SM '51, ScD '55, president of RCP Consultants in Needham, Mass., for "contributions to semiconductor device theory, integrated circuit technology, and microwave system applications"; and **Ronald W. Schafer**, PhD '68, institute professor and the John O. McCarty Chair Professor at Georgia Institute of Technology in Atlanta, for "research, teaching, and leadership in signal processing."

ACM's SIGCOMM has bestowed upon **Paul Green**, ScD '53, of IBM's Thomas J. Watson Research Center, its most prestigious lifetime achievement award for his outstanding contributions to the field. Green's work in data communications theory, protocols, architectures, and technology spans 50 years, making a major contribution in each of five decades: the first spread-spectrum system in the 1950s, channel-adaptive receivers in the 1960s, peer-centralized networks in the 1970s, protocol conversion in the 1980s, and most recently, all-optical networks with IBM's wavelength-division multiplexing project in the 1990s. After graduating from MIT, Green worked at Lincoln Lab from 1953 to 1969, when he joined IBM Research.... **Mitchel Resnick**, SM '88, PhD '92, has written *Turtles, Termites, and Traffic Jams: Explorations in Massively Parallel Microworlds* (MIT Press, 1994). *Technology Review* published a feature-article length excerpt from this book, entitled "Changing the Centralized Mind" in the July 1994 issue. Contrary to popular belief, complex phenomena like economic trends, the body's immune response, even bird-flock formations are not the result of careful direction by a central authority. In fact, they arise from simple individual behaviors and occur without any leader at all. The study of such intricate patterns can provide new insights and new tools for those who plan design.

The Association of Alumni and Alumnae has been notified of the following deaths: **LeRoy W. Evans**, SM '46, of Los Altos, Calif., on August 23, 1989; **Robert B. Patten**, SM '49, of Las Vegas, Nev., on February 14, 1994, and Captain **John R. Beardall, Jr.**, SM '49, of Winter Park, Fla., on November 1, 1993. No further information was provided.

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VI-A INTERNSHIP PROGRAM

Mid-September as I write, classes are underway and VI-A Final Reports on summer company assignments are in. By and large, company assignments were worthwhile and enjoyable. New VI-A Director **Markus Zahn**, '68, SM '68, EE '69, ScD '70, has been in touch with the companies and has already made some visits. With Lydia Wereminski continuing as the Program's administrative assistant, we look forward to a smooth transition of this historic MIT program! My own appointment as director VI-A (emeritus) and lecturer continues until June 30, 1995, which includes continuing to compile these notes, so I hope all you VI-A grads will continue to keep in touch.

Coming to my attention, after I had written my previous column, is an award received by Professor **Thomas J. Greytak**, '63, SM '63, PhD '67, of MIT's Physics Department. Tom was the recipient of a School of Science 1994 Teaching Prize for "excellence in education," for which we congratulate him. His citation reads "for his admirable taste and skill in selecting and presenting course material and for his effectiveness in maintaining intellectual standards while winning the gratitude and affection of his students." The presentation was made by **Robert J. Birgeneau**, dean of the School of Science.... **Melvin M. Weiner**, '56, SM '56, has addressed a meeting of the IEEE Boston Section's Antennas & Propagation Chapter on research done while he was a member of the technical staff at the Mitre Corp. Mel stopped in for a short visit not long ago, and we reminisced about our involvement on a national level with the Eta Kappa Nu Association back in the 1950s and '60s.

A letter from **Marion Reine**, '65, PhD '70, our VI-A coordinator at Loral Infrared & Imaging Systems in Lexington, Mass., tells of meeting Loral VI-A grads at this year's annual Infrared Information Symposium Detector Specialty Group Meeting in Boulder, Colo. Two papers were presented by former Loral VI-As: **Jeffrey D. Beck**, '72, SM '72, and **William A. Radford**, '82, SM '82. Jeff is with TI and Bill is with Santa Barbara Research Center. Other VI-As at the meeting included **Nancy M. Hartle**, '82, SM '82, supervisor of Loral's Detector Design & Test Department, **José L. Meléndez**, '90, SM '91, now of Texas Instruments, Inc., and **Theodore T.S. Wong**, '74, SM '74, who is VP for research, development, and engineering at Judson Research in Montgomeryville, Pa. Marion's interest and feedback is much appreciated.

An e-mail contact comes from **Philip O. Martel**, '72, SM '72, who tells of his leaving long-time employment at GE/Pittsfield, joining Textron Defense Systems for several years, then coming to Lexington, Mass., in 1993 to form SenTech, Inc., consultants in acoustics and signal processing.

Visitors to the VI-A office since last writing include: **Victor S. Abrash**, '86, with SRI of Santa Clara, Calif., **Charles N. Animalu**, '88, SM '88, back in the United States and with the Department of Physics and Astronomy at Western Kentucky University in Bowling Green, Ky., **Oscar P. Manley**, '57, SM '57, PhD '60, Department of Energy in Washington, D.C., and **Karl Sun**, '93, SM '93, a former advisee of mine, who's returning to MIT this fall for fur-

ther graduate study, having spent last year attending Harvard Law School.—John A. Tucker, director (emeritus), VI-A Internship Program, MIT, Room 38-473, Cambridge, MA 02139-4307; e-mail: <jat@fenchurch.mit.edu>

VII BIOLOGY

Nikki Levin, PhD '93, writes: "I'm currently in the second year of medical school at University of California at San Francisco. I was married on August 7, 1994, to Michael Christman, assistant professor of radiation oncology at UCSF." . . . **Daria Hekmatpanah,** PhD '91, and **Charles Scafe,** PhD '91, were married May 21, 1994. She is a postdoctoral fellow in biology at Yale University in New Haven, Conn. Scafe is a postdoctoral associate of the Howard Hughes Medical Institute, also at Yale.

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VIII PHYSICS

From Silver Spring, Md., **Tom Armstrong,** PhD '83, writes: "I have just been hired at the Naval Research Lab, in the Remote Sensing Division, to continue working on the Navy's stellar optical interferometer. I've been working on the interferometer since 1989, with Universities Space Research Association."

Lean and Clean Management: How to Boost Profits and Productivity by Reducing Pollution (Kodansha International, 1994) by **Joseph J. Romm,** '82, PhD '87, was published last October. According to a jacket blurb, the book "is a practical, comprehensive system that is already helping businesses reap phenomenal gains through intelligent energy use, green office and plant design, pollution reduction, and waste-free, lean management. With a wealth of new case studies, Romm reveals dramatic evidence for the coming revolution in the way America does business." Romm is the author of *The Once and Future Superpower: How to Restore America's Economic, Energy, and Environmental Security*. Before his current appointment as special assistant for policy to the deputy secretary of energy, Romm was a research scholar at Rocky Mountain Institute and taught at Columbia University's School of International and Public Affairs

Shirley Jackson, '68, PhD '73, a professor of physics at Rutgers since 1991, has been nominated by President Clinton to the Nuclear Regulatory Commission (NRC). Jackson served as a research associate at the Fermi National Accelerator Lab in Illinois after completing her studies at MIT. From 1974 to 1975, she was a visiting scientist in the theoretical division of the European Center for Nuclear Research in Switzerland. From 1976 to 1991, she worked at AT&T as a member of the theoretical physics research department, the solid state and quantum physics research department, and the optical physics research department. She still serves as a consultant to AT&T in semiconductor theory in addition to her teaching and research at Rutgers.

Charles S. Smith, Jr., ScD '40, of Farmington Hills, Mich., died on September 4, 1994. Smith was a professor emeritus of physics at the University of North Carolina at Chapel Hill. He began his career with a brief teaching stint at the University of Pittsburgh and then joined the faculty at Case Institute, now Case Western Reserve University, where he taught for 25 years. He served as chairman of the Physics Department in 1958–59 and spent sabbatical leaves at the Bell Telephone Labs in 1952–53 and Cornell University in 1960. Smith joined the UNC-CH Department of Physics in 1968 as university distinguished professor and director of the Materials Research Center. As director, he administered support for more than a dozen faculty members. Smith was an expert in using X-ray crystallography to study the behavior of elastic constants of crystals under high pressure. With students, he wrote 50 scholarly articles on microscopic crystalline interactions. He also became increasingly interested in teaching introductory physics and developing experimental labs for undergraduates. After retiring in 1981, Smith returned voluntarily each fall to teach an undergraduate laboratory class . . . **Richard E. Chamberlin,** '44, of Salt Lake City, Utah, died on March 14, 1994. He was professor emeritus of math at the Univer-sity of Utah. No further information was provided.

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IX BRAIN AND COGNITIVE SCIENCES

Harold G. Elrod, '42, professor emeritus of engineering science at Columbia University in New York, N.Y., has received the Mayo D. Hersey Award of the ASME. He graduated from Course IX when it was the Department of General Engineering. The award, established in 1965 and named for a leader in lubrication science and engineering, recognizes contributions to the advancement of those fields. Elrod was cited for "fundamental contributions to hydrodynamic lubrication theory in such diverse areas as surface roughness effects, non-Newtonian flow phenomena, thermo-hydrodynamics, film cavitation and starvation, and granular lubrication; and for efforts that led directly to improved bearing performance, modeling, and design." He taught thermosciences at the U.S. Naval Academy, Case Institute of Technology, Michigan State University, and for over 30 years Columbia University.

Richard J. Wurtman, Course IX professor of neuropharmacology and director of the MIT Clinical Research Center at MIT, has been named as the first holder of the Cecil H. Green Distinguished Professorship. Wurtman has been at the forefront of pioneering research that has established a strong link between the level of neurotransmitters and a variety of conditions ranging from Alzheimer's disease to Seasonal Affective Disorder. He has published more than 900 papers in his field. In the last few years, Wurtman and his colleagues have discovered that acetylcholine, a neurotransmitter abundantly present in the cortex of healthy subjects but in insufficient quantities in the brains of Alzheimer's disease victims, controls the formation of a protein which the brain can convert into fragments that disrupt brain function. The finding may hold the promise of a new treatment for the disease. In another area, a recent publication by Wurtman and his colleagues reported that the hormone melatonin, which is secreted by the body at night, can induce sleep when given in low doses to subjects during daylight hours. The discovery suggests that very low oral doses of melatonin, which do not present the side effects that accompany many sedatives, may become a useful drug for the treatment of insomnia. The MIT Clinical Research Center, which Wurtman directs, is the only center of its kind supported by the NIH that is not located at a hospital. The center is a fully equipped and staffed research facility that enables scientists to perform biological research involving human subjects. Students working at the center gain experience with human subjects and human disease. Research projects involve metabolism, psychiatry, neurology, and clinical pharmacology.

Cecil Green, founder of Geophysical Services, Inc., the predecessor company to Texas Instruments, Inc., of Dallas, is a 1923 graduate

of MIT. The Institute raised funds for this professorship using the Technology Licensing Office resources generated by the entrepreneurial output of faculty and research staff. The philanthropy of Green, a Life Member emeritus of the MIT Corporation, and of his late wife, Ida, has played a major role in the development of educational and medical institutions across the United States and the world. At MIT, the Greens have donated millions of dollars for projects that include two buildings, nine endowed professorships, and a fellowship program for female graduate students. They have given their names to the 20-story Cecil and Ida Green Building, which houses the Department of Earth, Atmospheric, and Planetary Sciences, and to Ida Flangsbergh Green Hall, MIT's first residence hall for women graduate students. The Green Center for Physics, a major renovation project, will provide new facilities for the Department of Physics under a $6 million gift from Green.

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X CHEMICAL ENGINEERING

Frank Gentile, PhD '88, writes: "I am currently a senior project manager at Cyto Therapeutics in Providence, R.I. I am responsible for developing artificial organs for the treatment of ALS (Lou Gerhig's disease), Alzheimer's, and Parkinson's. I'm also an adjunct professor at Brown University. I have three sons, Stefan, 4, Ben, 3, and Sam, 1. My wife, Erin Fox Gentile, is a law student." . . . From Cincinnati, Ohio, **Joseph B. Farrell**, SM '47, sends word: "I retired from the EPA in May 1993, after 27 years in R&D, mostly on processing of sewage sludge, reduction of pathogens in sludge, and regulations for sludge use and disposal. I still do some consulting on pathogen issues. Strangely, I met few MIT people in my years at the EPA (all in Cincinnati). My last significant contact with an MIT alum was with **Bob McBride**, when he was with Texas Gulf Sulfur. He was a consultant for Manhattan College's Chemical Engineering Department where I was teaching about 30 years ago. I believe Bob is still class secretary for the 1947 class."

News for **George A. Sofer**, SM '50, CHE '51, ScD '52: "I retired from Exxon Nuclear, which later assumed the name Siemens Power Corp., on January 1, 1993. I am spending most of my time writing a book on the wonderful experiences I have witnessed, starting in Baghdad and Tel-Aviv, and continuing into Pennsylvania, Cambridge, White Plains, N.Y., Brussels, Belgium, and the state of Washington." . . . From Columbus, Ohio, **John D. Ireland**, SM '47, informs us that he retired in January 1993 .

Albert D. Richards, SM '83, SM '86 (XV), PhD '86, has been named VP and manager of European equity research at Salomon Brothers in London, England. He was director of research and chemical analyst for the European sector at Credit Suisse First Boston, Ltd., also in London.

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X-A PRACTICE SCHOOL

Editors and writers have a constant tug of war: writers want more space and editors want them to use less, thus saving paper and money. This time the editors win by default—almost no news.

And most of what there is comes from Carol Phillips in the X-A office. As of August 1, 1994, **Andre Le Cesne**, SM '94, is a member of the Environmental Conservation Department at the Shell Oil Refinery, Norco, La. . . . Back in the U.S. for the summer after two years' experience in Japan, **Tim Donahue**, SM '87, PhD '92, made the rounds of Building 66. He's now at the United Technologies Research Center in Tokyo, monitoring Japanese activities (technical liaison, they call it) and doing research in the fields of materials science and chemical engineering. . . . After finishing X-A in August 1994, **Nabil Triki**, SM '94, recovered with a trip home to France and Italy, then went to work in the Advanced Technology Group at Allied Signal Corp., Torrance, Calif., doing R&D on fuel cells for transportation applications.

The Alumni/ae Association has been informed of the death in 1993 of **F. Philips Pike**, SM '36, in Raleigh, N.C. His distinguished professional career was devoted almost entirely to teaching and research in chemical engineering at the University of South Carolina. Send news to the undersigned or to Carol Phillips in the SCEP office, MIT Room 66-309, or to <carol@pracschool.mit.edu>.—John Mattill, *Technology Review*, W59-200, MIT, Cambridge, MA 02139.

XI URBAN STUDIES AND PLANNING

News from **Judith Innes**, PhD '73, in Albany, Calif.: "I am now director of the Institute of Urban & Regional Development at the University of California at Berkeley, and I continue to teach in the Department of City & Regional Planning." . . . From Limassol, Cyprus, **Mahmoud Shabandar**, MCP '76, sends word: "We have managed to locate no fewer than 23 MIT alumni in Cyprus. We are planning to hold our first group event in October 1994. Will this be the start of the MIT Club of Cyprus? We shall keep you informed." . . . **Sara B. Freedheim**, MCP '93, reports from Alexandria, Va.: "I have been working since June 1993 at the World Bank in the technical department of the Latin American and Caribbean region. I married David S. Newman on October 15, 1994." . . . **James M. Symons**, SM '55, ScD '57, professor of civil engineering and director of the environmental engineering program at the University of Houston, has been inducted into the NAE for "major research discoveries that significantly advanced the understanding and practice of improving drinking water safety."

Phillip Clay, PhD '75, has been named associate provost of MIT, effective October 1, 1994. In his new position, Clay is responsible for policies of promotion and tenure at MIT, for academic integrity, for faculty recruitment and retirement, and for international educational programs. Clay, who will work closely with President Charles Vest and Provost Mark Wrighton, is specifically interested in developing effective actions to seek more minority faculty members for MIT. At MIT since 1974, Clay has been a Course XI assistant professor, 1974–79; manager of program evaluation for Neighborhood Reinvestment Corp. (Washington, D.C.), 1979–80; assistant director of the Joint Center for Urban Studies of MIT and Harvard, 1980–84; associate professor, 1980–92; associate department head, 1989–92; and Course XII department head and professor, 1992–present.

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XIII OCEAN ENGINEERING

From Westerly, R.I., **Henry J. Nardone**, '52, sends word: "I received an honorary doctor of Laws from the University of Rhode Island in 1993. It is the second honorary doctorate I have received. I retired from General Dynamics after 37 years and am now a consultant for my previous employer and the Westerly Hospital." . . . Commander **Kevin Carpentier**, SM '82, reports: "I reported for duty as executive officer, USCG cutter *Rush* (WHEC 723), homeported in Honolulu, Hawaii. On my first patrol, *Rush* visited Guatemala, Panama, and Colombia as part of a professional exchange with the navies and coast guards of those countries." . . . **Richard MacDougal**, SM '74, writes from The Woodlands, Tex.: "I am director of drilling and production for Union Texas Petroleum."

Robert W. McCarthy, SM '85 (II, XIII), writes: "I was promoted to commander, U.S. Coast Guard, in July 1994. I am currently serving as the Coast Guard attaché and police attaché at the U.S. Embassy in Bogotá, Colombia." . . . **Gerald C.K. Hsu**, SM '75, has been named president and CEO at ArcSys, Inc., in Sunnyvale, Calif. Previously, Hsu was president and general manager of the IC Design Division at Cadence Design Systems, Inc., in San Jose, Calif. . . . Two Navy updates: Lieutenant Commander **Dennis C. Logan**, SM '91 (II, XIII), recently reported for duty with Commander, Naval Surface Group Mediterranean, in Naples, Italy. Commander **Kevin M. McCoy**, SM '89 (II), NE '89, reported for duty aboard the submarine tender USS *L.Y. Spear*, homeported in Norfolk, Va.

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>.**

XIV ECONOMICS

President Clinton has named **Lars A. Stole**, PhD '91, assistant professor of business economics at the University of Chicago Graduate School of Business, as the winner of a 1994 Presidential Faculty Fellow award for his career work in economics. The award recognizes young faculty members who demonstrate excellence in research and teaching. The award, which includes a grant from the NSF, is intended to allow a Fellow to undertake self-designed research and teaching projects, to establish research and teaching programs, and to pursue other academic activities. Stole joined the faculty of the Graduate School of Business at the University of Chicago in 1991. He was an Olin Fellow at Harvard Law School from 1988 to 1989, and he received an MS in economics from the London School of Economics in 1986. Stole's research focuses on developing the economics of incentives, including price discrimination, non-monetary trade, and the construction of optimal contracts and organizational designs. Among his recent teaching activities, he has also created and taught a short course on economics to government officials and enterprise managers in Prague and Bratislava. Stole is one of 30 who received the 1994 Presidential Faculty award.

John G. Turnbull, PhD '47, of West Saint Paul, Minn., died on August 4, 1994. Turnball joined the faculty at the University of Minnesota in 1949 as a professor of economics. He served as the assistant and then the acting dean of the College of Liberal Arts. Turnball won the Distinguished Teacher Award from the College of Liberal Arts in 1973, one year after he resigned the deanship to return to teaching full-time. . . . **Robert J. Agnew**, PhD '53, of Pittsburgh, Pa., died on September 6, 1994. Agnew was professor emeritus at the Joseph M. Katz School of Business at the University of Pittsburgh, where he taught from 1952 to 1982. Agnew's academic studies were interrupted during the depression years and WWII Before the war and for a time after, he worked as an inspection foreman at the Youngstown Sheet and Tube Co., where he gained invaluable experience that contributed to his understanding and teaching of labor relations and management-employee relations. During WWII he served in the Navy from 1942 to 1945. He belonged to many

organizations, including the American Economic Association, the American Sociological Society, and the American Arbitration association. He was called to serve as an arbitrator in many local and national public and industrial management-employee disputes. He served Westinghouse Electric Co., Mine Safety Appliance Research Co., and others. After retirement from the University of Pittsburgh in 1982, Agnew was asked to serve with the International Executive Service Corps as a consultant on the case method to the faculty of the Asian Institute of Management in Manila, the Philippines.

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>.**

XV MANAGEMENT

Roberta L. Kowalishin, SM '94, has been named a VP at J.P. Morgan & Co., Inc., in New York, N.Y. . . . **Albert D. Richards,** SM '83 (X), SM '86, PhD '86 (X), has been named VP and manager of European equity research at Salomon Brothers in London, England. He was director of research and chemical analyst for the European sector at Credit Suisse First Boston, Ltd., also in London. . . . **Michelle S. Wolf,** SM '88, has joined the international law firm of McDermott, Will & Emery, as an associate in the Health Law Department. She will be based in the company's Boston office. . . . **Erika Williams,** SM '78, VP and general manager of Amdahl Corp.'s Enterprise Storage Systems operations in Sunnyvale, Calif., has been appointed to the seven-member board of directors of Cincinnati Microwave, Inc., a manufacturer of electronic communications devices in the radio frequency and microwave transmission spectrum. Williams joined Amdahl Corp. in 1978 and held a variety of senior posts in hardware and software development, marketing, corporate planning, and product management prior to assuming her current position as head of the company's $300-million data storage business.

Marshall L. Fisher, '65 (VI), SM '69, PhD '70, the Heyman Professor of Operations Management at the University of Pennslyvania, for "advances in solving large-scale engineering problems in vehicle routing and logistics." . . . **Andrew W. Lo,** Course XV finance professor, has been named the first Harris & Harris Group Senior Professor at MIT. Lo is an economist noted as an expert in computational finance and financial engineering. The chair was established in 1993 by the company, a publicly owned business development company that commercializes intellectual property and co-founds and develops newer companies. A member of the Sloan faculty since July 1988, Lo spent the four years prior teaching at the Wharton School at the University of Pennsylvania.

SLOAN FELLOWS

From Fairfax, Va., **Roosevelt Jones,** SM '70, writes: "I retired February 3, 1994. I was formerly director at the Office of Procurement and Contracts at the U.S. Department of Housing and Urban Development. I'm currently chairman of the board of directors of the Credit Union Mortgage Association, a metropolitan-Washington-area mortgage company wholly owned by 28 local credit unions." . . .

Larry Knauer

Larry D. Knauer, SM '87, has been named deputy director of the Super Lightweight Tank (SLWT) project at Martin Marietta Manned Space Systems in New Orleans. Knauer joined the company in 1981 and most recently served as director of engineering for the Martin Marietta Space Group. . . . **William J. Lhota,** SM '78, has been named director at the State Auto Financial Corp., in Columbus, Ohio. He was executive VP for operations at the American Electric Power Service Corp., also in Columbus

Bruce Gordon, SM '88, Bell Atlantic Corp.'s group president of consumer and small business services, has been named to the senior management team slated to lead the company toward the communications, information, and entertainment industries. The team—called the Office of the Chairman—is the corporation's top decision-making body. Prior to his current position, Gordon served as VP for sales and marketing for several years before being promoted to president of consumer services. He also has had assignments in operations and personnel since joining Bell Atlantic in 1968. Gordon is a founder of the Alliance of Black Managers and has served as director of the Urban League. . . . **Allan R. Rothwell,** SM '93, has been appointed VP and general manager of the Container Plastics Business Organization at Eastman Chemical Corp. in Kingsport, Tenn. Rothwell began his 25-year career with Eastman as a chemist. . . . Also at Eastman, **Darryl K. Williams,** SM '90, has been named VP for Asia Pacific sales. Williams served as president of Eastman Chemical Japan, Ltd., and managing director of Asia-Pacific Regional Support Services. Williams began his career as a chemical engineer for Tennessee Eastman Division in 1965. He resides in Tokyo, Japan.

Allan Rothwell

Darryl Williams

Edward Scott Pattison, '39, of Dunedin, Fla., died on June 29, 1994. He was employed for over 40 years in New York City, first with the McGraw Hill Publishing Co. Later he served as executive VP of the G.M. Basford Co., an advertising agency. He also served as president of the Soap and Detergent Association prior to his retirement in 1971. He was a longtime member of the Chemists' Club in New York and the American Chemical Society, in addition to others.

SENIOR EXECUTIVES

Mei-Wei Cheng, '90, has been named president and CEO of GE China. In his new position, Cheng will be responsible for leading the business development, marketing, and government relations activities of GE's growing China business operations. Cheng spent the last 22 years at AT&T, his final position being president of AT&T China . . . **Ronald D. Parker,** '91, has been appointed president and CEO of Homestake Canada, Inc., a wholly owned subsidiary of Homestake Mining Co. Parker is also president and CEO of Prime Resources Group, Inc., which is 50.6 percent owned by Homestake Canada. He joined Homestake in 1986 . . . **George A. Sissel,** '84, has been elected acting president and CEO of the Ball Corp. until a permanent replacement can be found. Sissel, who joined the company in 1970, is senior VP for corporate affairs as well as corporate secretary and general counsel for Ball Corp. . . . **Nestor R. Ortiz,** ScD '72 (XXII), '91, was presented the Hispanic Engineer National Achievement Award (HENAA) for the Professional Achievement category at a conference in Houston, Tex., last October.

The Association of Alumni and Alumnae has been notified of the following deaths: **Howard L. Minckler,** '62, of Bronxville, N.Y., on May 10, 1994, and **Martin V.C. Bradley, Jr.,** '82, of Dallas, Tex., on December 20, 1993. No further information was provided.

Alumni/ae may send information for Course News to **<mitalum@mitvmc.mit.edu>.**

XVI AERONAUTICS AND ASTRONAUTICS

Tito A. Rodriguez, Jr., SM '84, sends an update: "After MIT I moved out to Los Angeles where I was employed by Hughes Aircraft. After seven years helping to launch several satellites on the Shuttle, and many volleyball games, I returned to school. In June 1993, I received an MBA from Wharton (U. Penn) and joined Mars & Co., a consulting firm in Greenwich, Conn. After a year of commuting to Mexico City, my wife and I are being transferred to Buenos Aires, Argentina, for a new assignment." . . . **Eric J. Sheppard,** SM '85, PhD '94, writes: "I am now an assistant professor of aerospace science engineering at Tuskegee University in Tuskegee, Ala." . . . A report from **Charles A. Vehlow,** SM '74: "I am the program director of the AH-640 Longbow Apache program at McDonnell Douglas Helicopter Systems in Mesa, Ariz." . . . **Mark T. Salzberger,** SM '94, reports: "After nine years of service as a naval flight officer and NROTC instructor at MIT, my wife, Ann, our three children, and I have moved to Michigan. I am now working there as a manufacturing engineer for the Stayker Corp., makers of medical instruments and a fast-growing company. We do not miss the drivers of Boston. A special greeting to Course XVI Professor **R. John Hansman,** great achiever, thesis advisor, and an all-around good guy."

Rear Admiral **Thomas C. Betterton,** SM '66, EAA '66, USN (ret.), writes: "I retired from the Navy in February 1992, after a 35-year career—aerospace engineering duty officer. I was recalled to active duty for three months,

September 1992–December 1992, to serve on the Mars Observer Failure Investigation Board for NASA. I'm currently re-retired, a consultant in space systems, and I reside in Alexandria, Va." . . . **Albert W. (Bill) Johnson**, SM '58, sends word: "After graduating from MIT, I was associated with the Air Force Office of Special Projects for 21 years and then Lockheed for 13 years. During this time, I worked on the Discoverer (the World's first military satellite), chased capsules returned from space in the Pacific and South America, worked in the Pentagon (Office of Space Systems), and contributed to the design and operation of various Air Force and Department of Defense Systems. I recently retired to my wife, Dottie's, and my home on the shore of the Magothy River in Maryland. I plan to enjoy my boat, my grandchildren, and any old friends who would like to visit. (410) 647-4755." . . . **Harry Elias Stephens**, SM '74, has been named executive VP and COO at Grist Mill Co. in Lakeville, Minn. He was a principal at the Northern Group, Inc., in Seattle, Wash. . . . **George G. Kaminski**, SM '66 (VI, XVI), chairman and CEO of Technology Strategies and Alliances in Burke, Va., was inducted as a member of NAE for "leadership and technical contributions to stealth technology and military systems."

The Association of Alumni and Alumnae has been notified that Colonel **Anthony Q. Mustoe**, '36, (ret.), of Rutherfordton, N.C., died on April 3, 1994. No further information was provided.

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XVII POLITICAL SCIENCE

David H. Guston, PhD '93, writes: "I have just joined the faculty at Rutgers University in New Brunswick, N.J., as an assistant professor in the Department of Public Policy." . . . From Washington, D.C., **Steve Pieczenik**, PhD '82, reports: "I will have a double winner in January. My fourth novel, *Pax Pacifica*, will be published by Warner Books, and a four-hour mini-series, entitled *OP Center* that I co-created with author Tom Clancy, will be aired on NBC." . . . **Vann H. Van Diepen**, SM '83, sends word from Arlington, Va.: "I married Louise R. Rodriguez on October 10, 1994, aboard the paddlewheeler *Cherry Blossom* on the Potomac River. I am director of chemical, biological, and missile nonproliferation at the U.S. Department of State." . . . **Avivah D. Litan**, SM '79, writes from Rockville, Md.: "I was promoted this year to a division chief at the World Bank, where I manage more than 50 computer professionals and consultants."

Three Course XVII alums have recently published new books. **Stephen Amberg**, PhD '87, is the author of *The Union Inspiration in American Politics: The Autoworkers and the Making of a Liberal Industrial Order* (Temple University Press, 1994). Amberg analyzes how unions went from contributing to "a virtuous circle of rising wages and benefits, economic growth, steady profits, and consensus on social reform" to the ruins we see today. Amberg is associate professor of political science at the University of Texas at San Antonio. Course XVII Professor . . . **Eugene B. Skolnikoff**, '50 (VI), SM '50 (VI), PhD '65, has written *The Elusive Transformation: Science, Technology, and the Evolution of International Politics* (Princeton University Press, 1993). According to the book jacket, Skolnikoff "shows how the structure and operation of the scientific and technological enterprises have interacted with international affairs to lead to the dramatic evolution of world politics experienced in this century, particularly after WWII. The author questions, however, whether the underlying principles of the nation-state system have in fact been appreciably changed and concludes that, with few exceptions, the fundamental assumptions of international affairs have not been altered." Skolnikoff has been director of the Center for International Studies at MIT, and has served on the staff of the White House Office of Science and Technology in several administrations.

Charles Murray, PhD '74, and Richard J. Herrnstein are the authors of *The Bell Curve: Intelligence and Class Structure in American Life* (The Free Press, 1994). Its controversial content is explained by the authors: "This book is about differences in intellectual capacity among people and groups, and what those differences mean for America's future. The relationships we will be discussing are among the most sensitive in contemporary America—so sensitive that hardly anyone writes or talks about them in public. It is not for lack of information, as you will see. To try to come to grips with the nation's problems without understanding the role of intelligence is to see through a glass darkly indeed, to grope with symptoms instead of causes, to stumble into supposed remedies that have no chance of working. We are not indifferent to the ways in which this book, wrongly construed, might do harm. We have worried about them for the day we set to work. But there can be no real progress in solving America's social problems when they are misperceived as they are today."

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XVIII MATHEMATICS

From Arnold, Md., **Peter J. Welcher**, PhD '78, writes: "I quit my full professorship at the U.S. Naval Academy and am now doing Cisco router training, router-related programming, and network consulting as a senior consultant with Chesapeake Computer Consultants." . . . Via e-mail, **Michael Zuker**, PhD '74, sends word: "I am pleased to announce that I have accepted a faculty position within the Institute for Biomedical Computing at Washington University in St. Louis, Mo. This institute is situated adjacent to the medical school and Genome Sequencing Center at Washington University, but it is also affiliated with the School of Engineering and Applied Sciences and puts me in an enviable position of being close to many potential collaborators. I have joint appointments in the Genetics and Biochemistry Departments at the medical school and another 'courtesy' appointment in the Applied Mathematics and System Science Department in the Engineering School. I left the NRC at the end of June and started my new position last September. I can be reached at <zuker@ibc.wustl.edu>."

William H. Barker, PhD '73, professor of mathematics at Bowdoin College in Brunswick,

Me., has won an NSF Leadership Award to improve science laboratory instruction in undergraduate courses. The award, in the amount of $90,159, is from NSF's Division of Undergraduate Education, and was based on merit review of the proposal submitted by Barker as part of a national competition. Entled "Mathematica Computer Laboratory Instruction in Calculus and Applied Mathematics," Barker's project is serving as a national model for undergraduate laboratory instruction of Mathematica, a powerful computer software integration of symbolic and numeric computational routines, graphics, and text processing used by Barker as part of Project CALC, a radical restructuring of the traditional calculus curriculum designed to encourage learning through the application of calculus topics to important "real world" problems. He is project director for Project CALC at Bowdoin, which is serving as a primary testing and development site for the project within a liberal arts setting. Barker has been a member of the Bowdoin faculty since 1975, when he was named assistant professor of mathematics. He was promoted to associate professor in 1981, and to his current position in 1989

Mark Kantrowitz, '89 (XVIII, XXIV), is the editor of *Prime Time Freeware for AI: Selected Materials from the Carnegie Mellon University Artificial Intelligence Repository* (Prime Time Freeware, 1994). The book is actually a collection of AI-related freeware: 5,000 megabytes of free source code and documentation, stored as compressed archives on two ISO-9660 CD-ROMs. The author has been programming in Common Lisp and other AI-related programming languages for over a decade. He has worked at the Planning Research Corp., Bitstream, and the MIT Artificial Intelligence Lab. He maintains the monthly Frequently Asked Question (FAQ) postings for the AI, Expert Systems, Common Lisp, CLOS, Scheme, and Prolog newsgroups, among others, on the Internet. This is Kantrowitz's third book. He edited the 7th edition of the *Guide to Living in Pittsburgh* and wrote the *Prentice Hall Guide to Scholarships and Fellowships for Math and Science Students.*

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XX APPLIED BIOLOGICAL SCIENCES

Linda Lion, PhD '75, a 17-year veteran of the U.S. Agency for International Development (USAID), has been sworn in as the Agency's director of the Regional Support Mission in Bangkok. The purpose of this mission is to provide technical and administrative support to USAID's activities throughout East Asia. Currently, USAID has projects in the East Asian countries of Thailand, Mongolia, Cambodia, Vietnam, and Laos. During her career, Lion has served in Jamaica, Guyana, Pakistan, and Peru. She has specialized in the population and health sector. Most recently she made a major contribution to the reinventing of USAID as deputy director of the Office of Information Resources Management. . . . **Renato Fuchs**, SM '69, PhD '74, senior VP for manufacturing and development operations at Chiron Corp., in Emeryville, Calif., has been inducted as a member of NAE for "engineering contributions in the design, construction, and operation for large-scale manufacturing of recombinant DNA proteins."

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XXII NUCLEAR ENGINEERING

James K. Liming, SM '83, sends word from Fountain Valley, Calif.: "I'm the Southern California branch office manager for Erin Engineering and Research, Inc. We specialize in engineering and management consulting. We're currently performing risk analysis and reliability engineering projects for nuclear power plants, weapons systems, chemical process plants, and other complex process facilities worldwide." . . . From Pleasanton, Calif., **Mat Waltrip**, SM '89 (II, XXII), reports: "I am now coordinator for the NUHOMS Owners Group, composed of our utility clients and international licensees who are actively involved in using the company's system for storage and transportation of spent nuclear fuel. My company, Vectra, is pursuing a contract to design and license the multi-purpose canister (MPC) for the Department of Energy. My wife and I just purchased our first home."

Ralph T. Soule, SM '91 (VI, XXII), sends an e-mail update: "I am currently assigned to the Puget Sound Naval Shipyard in Bremerton, Wash. I am responsible for the completion of nuclear repair work on the USS *Nimitz* (CVN 68), which is in the shipyard for a 12-month maintenance period. In one year, it will require over 300,000 man-days of work. Thus far it is right on schedule." . . . **Nestor R. Ortiz**, ScD '72 (XXII), '91, was presented the Hispanic Engineer National Achievement Award (HENAA) for the Professional Achievement category at a conference in Houston, Tex., last October. . . . **Philip F. Palmedo**, SM '58 (X), PhD '61, and Edward Beltrami are the authors of *The Wines of Long Island: Birth of a Region* (Waterline Books). Palmedo heads the Long Island Research Institute in Setauket (which channels research to industry) and is a former Brookhaven National Lab physicist. During an 18-month stint as a physicist in Paris, Palmedo developed a passion for wine.

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XXIV LINGUISTICS AND PHILOSOPHY

Mark Kantrowitz, '89 (XVIII, XXIV), is the editor of *Prime Time Freeware for AI: Selected Materials from the Carnegie Mellon University Artificial Intelligence Repository* (Prime Time Freeware, 1994). The book is actually a collection of AI-related freeware: 5,000 megabytes of free source code and documentation, stored as compressed archives on two ISO-9660 CD-ROMs. The author has been programming in Common Lisp and other AI-related programming languages for over a decade. He has worked at the Planning Research Corp., Bitstream, and the MIT Artificial Intelligence Lab. He maintains he monthly Frequently Asked Question (FAQ) postings for the AI, Expert Systems, Common Lisp, CLOS, Scheme, and Prolog newsgroups among others on the Internet. This is Kantrowitz's third book. He edited the 7th edition of the *Guide to Living in Pittsburgh* and wrote the *Prentice Hall Guide to Scholarships and Fellowships for Math and Science Students.*

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TPP TECHNOLOGY AND POLICY PROGRAM

David Hanrahan, SM '79, is currently an environmental policy analyst in the Environment Department at the World Bank in Washington, D.C. He is working with a group of environmental economists on a range of pollution and natural resources projects, trying to build on some of the Bank project work to help develop some practical sustainable development policies. . . . **Roger Kilgore**, SM '81, joined Greenhorne & O'Mara, Inc., on August 15, 1994, as the senior consultant for environmental services. His main responsibilities will be business development, technical analysis, and special projects for the Greenbelt, Md., headquarters office. . . . **Dwayne S. Breger**, SM '83, received a PhD in resource economics at the University of Massachusetts at Amherst. As of September, 1994, he is an assistant professor at Lafayette College in Easton, Pa., in support of the AB in Engineering Program which, on an undergraduate level, has very similar objectives as TPP. His two sons, Alex and Benjamin, are now 7 and 3. . . . Sophie and Claire Paillas take great pleasure in announcing the birth of their younger sister, Charlotte, on July 21, 1994. Natalie and **Eric Paillas**, SM '84, are the busy parents. . . . **Alice Outwater**, SM '87, has completed a sludge reuse handbook for CRC Press and is almost finished with *The Cartoon Guide to Environmental Science* with Larry Gonick for Harpers Collins. She also has a third book contract from Basic Books for an ecohistory of water, entitled *Land Alive: Water for the 21st Century.*

Ajit Kambil, '85 (VI), SM '89 (TPP, XV), PhD '93 (XV), informs us that things are going well at New York University and he is involved in a variety of research projects, some of which are pulling him back into the policy arena. One year ago, he received an NSF grant to put the Securities and Exchange Commission's EDGAR database on-line for broader public access. Other research projects are more focused on the effects of technology on firm strategy. . . . **Caleb King**, SM '90 (I, TPP), is a resident in pediatrics at Children's Hospital in Boston. . . . **Hotasi Nababan**, SM '93 (I, TPP), was promoted in March 1993 to manager of economic planning for the Bureau of Corporate Planning and Development in Indonesia. . . . **Frank Felder**, SM '94, has been working in Buenos Aires since graduation, with a retired electric utility executive, on the prospects of conservation and efficiency under the recently privatized and deregulated electricity sector.

Henri Poupart-Lafarge,SM '94, has started working at the French Ministry of Budgets. . . . Congratulations to Catherine and **Nicholas Terraz**, SM '94, on their marriage. They spent their honeymoon on La Reunion, which is a French island near Africa. . . . Michelle and **Scott Wright** (G '95), have an addition to their family: Maxwell.—Richard de Neufville, chair TPP, MIT, Room E4-252, Cambridge, MA 02139

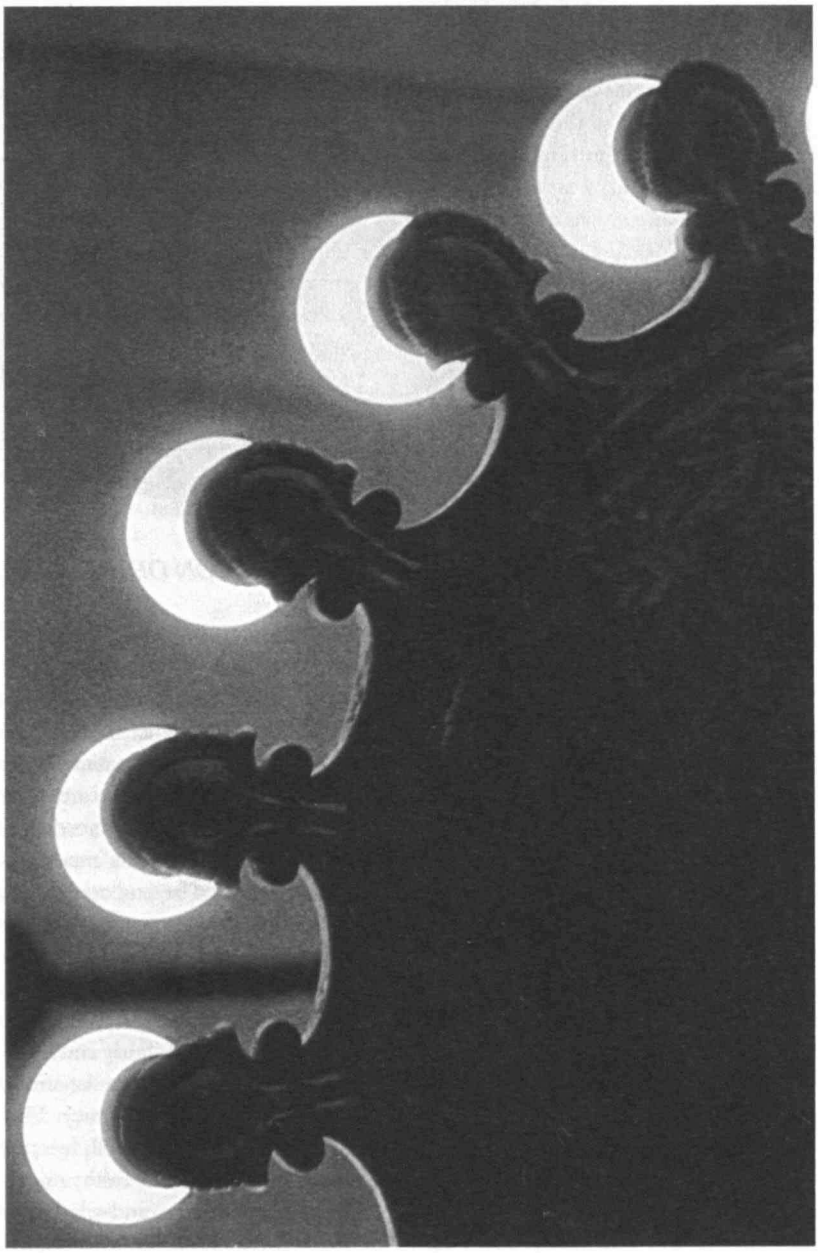
Deceased

The following deaths have been reported to the Alumni/ae Association since *Review* last went to press:

Roswell F. Barratt, '14; April 18, 1994; Southport, Conn.
Leon I. Snow, '18; February 14, 1994; Westport, Conn.
Irving H. Wilson, '20; July 17, 1994; Havertown, Pa.
Louis Domingues, SM '23; May 28, 1994; Kerrville, Tex.
Max M. Sandfield, '25; April 12, 1994; Dallas, Tex.
Frazier P. La Boon, '26; June 6, 1994; McLean, Va.
Harold J. Ryan, '26; August 8, 1994; Kings Park, N.Y.
Arthur H. Alden, Jr., '27; June 12, 1994
Fordyce Coburn, '27; August 21, 1994; Pueblo, Colo.
James Clifton Edgar, '28, SM '29; March 6, 1994; Cary, N.C.
Banjamin K. Hough, Jr., 28, SM '32; March 30, 1994; Alexandria, Va.
Robert G. Kales, '28; January 24, 1994; Grosse Pointe, Mich.
Murrice O. Porter, SM '29; 1994; New York, N.Y.
Ralph H. Draut, '30; April 10, 1994; Altamonte Spring, Fla.
Frank H. Hankins, Jr., '30; August 10, 1994; Fort Pierce, Fla.
Ludwig P. Jandris, '30; August 15, 1994; South Hadley, Mass.
John Parmakian, '30; August 15, 1994; Boulder, Colo.
James A. Wye, '31; August 26, 1994; North Quincy, Mass.
Dan M. Kentro, '32; August 13, 1994; Tucson, Ariz.
John Zouck, '32; July 13, 1994; Glyndon, Md.
John S. Brinkler, Sr., '34; March 9, 1994; Deerfield, N.H.
Winton Brown, '34, SM '35; October 18, 1993; Winchester, Va.
John J. Driscoll, '34; July 21, 1994; W. Hartford, Conn.
Anthony Q. Mustoe, '36; April 3, 1994; Rutherfordton, N.C.
Julian S. Rifkin, '36; August 5, 1994; Duxbury, Mass.
George R. Robinson, '36, SM '37; July 22, 1994; Clark, N.J.
Louis E. Stahl, '36; August 29, 1994; Swampscott, Mass.
James B. Henderson, '37; June 18, 1994; Wheaton, Md.
Cornelius Kingsland Coombs, '38; August 24, 1994; Lebanon, Ohio
Edward Scott Pattison, '39; June 29, 1994; Dunedin, Fla.
Charles S. Smith, Jr., ScD '40; September 4, 1994; Farmington Hills, Mich.
M. Arnold Wight, Jr., '40; August 4, 1994; Amherst, N.H.
Malcolm J. Dodd, '41; August 14, 1994; Tucson, Ariz.
Alfred T. Dengler, '42; August 23, 1994; Weston, Mass.
Herbert D. Landes, Jr., '42; June 29, 1992; Salt Lake City, Utah
John S. Stewart, Jr., '42; April 11, 1994; Norwalk, Ohio
Edward H. Williams III, '44; March 17, 1994; Daytona Beach, Fla.
Bradley Hahn, '45; April 3, 1992; Perkiomenville, Pa.
Claude M.A. Lebel, '45, SM '46; September 10, 1990; Paris, France
Leroy W. Evans, SM '46; August 23, 1989; Los Altos, Calif.
John G. Holmes, '47; July 24, 1994; Sun City, Ariz.
John G. Turnbull, PhD '47; August 4, 1994; West Saint Paul, Minn.
JRobert H. Thena, '48; July 24, 1994; Lakewood, N.J.
John R. Beardall, Jr., SM '49; November 1, 1993; Winter Park, Fla.
Isaac C. Foster, '49, '50; June 29, 1994; Spartanburg, S.C.
Robert B. Patten, SM '49; February 14, 1994; Las Vegas, Nev.
Donald W. Ericson, '50; November 8, 1993; Saint Charles, Ill.
George E. Hogue, '51; August 5, 1994; Westminster, Md.
Basil A. Bonk, '59, SM '60; May 1, 1994; Baltimore, Md.
Jack D. Jones, '61; September 20, 1994
Daniel Beltran-Maldonado, SM '62, ScD '65; April 11, 1994; Bosques De Las Lomas, Mexico
Howard L. Minckler, '62; May 10, 1994; Bronxville, N.Y.
Emil Stang Lund, '65, SM '65; November 28, 1993; Oslo, Norway
David B. Alperin, '70; August 24, 1994; Danvers, Mass.
Martin W. Donovan, Jr., '71; August 26, 1994
Daniel Poon Sech Chan, SM '74; January 1974; Stamford, Conn.
Siong H. Chua, '79, SM '80; August 15, 1994
Martin V.C. Bradley, Jr., '82; December 20, 1993; Dallas, Tex.

REPORT OF THE PRESIDENT

For the Academic Year 1993–1994



A STATE WITHOUT THE MEANS OF SOME CHANGE IS WITHOUT THE MEANS OF ITS CONSERVATION.

Edmund Burke, *Reflections on the Revolution in France*

AMERICAN HIGHER EDUCATION MUST ADDRESS the challenges of a new era. This requires not only introspection regarding our mission and the changing environment in which we serve society, but also rethinking our relationship and interaction with both industry and the federal government. Global economic competition and accelerating social and technological change have altered much of what is needed in our educational and research programs. Changing national priorities and attitudes, including an increasingly pervasive cynicism, are remaking the landscape of federal science and technology policy, with strong ramifications for our universities.

We must enthusiastically address the challenges of this new era, yet it is essential that fundamental values of the academy not become victims of short-term or localized thinking, despite the necessity for evolution and change within the system of higher education. Likewise, commitment to academic values must not imply rigidity and resistance to change.

Consideration of both the larger issues and specific instances of opportunity and challenge illuminate the new pathways we must pursue.

A CHANGING ENVIRONMENT FOR EDUCATION AND RESEARCH

THE END OF THE COLD WAR, THE STUNNING advances in information technology, global economic competition, and the changing demography of America are rapidly creating new expectations, responsibilities, and opportunities for institutions of higher education, and especially research universities:

● The military needs of the Cold War era and the culture of superpower competition created a public and political climate of support for advanced education and research. Defense became the dominant driver of high technology and provided an underlying rationale for the support of much basic science as well. The benefits of this support extended far beyond our security, narrowly defined, to build new industries and national capabilities through an enhanced knowledge base and a more highly educated citizenry. This now has changed abruptly. The cold peace that we have won has eroded this supportive climate, and left the compass of national policy spinning, rather than locked onto new directions that would unite, inspire, and advance us.

● In a generation, computers have grown from curious devices to a ubiquitous technology of unprecedented power and influence. Information technology now links us across time and space in a manner that is revolutionizing human organizations. How knowledge is acquired and operated upon, and how work is accomplished in the future are likely to be so influenced by information technology as to be unrecognizable in today's context.

● We already live in a global society. Most notably, our corporations buy, sell, produce, employ, and compete in countries all over the world. They interact continuously across national, cultural, and linguistic borders. Even so, most American citizens continue to lead rather isolated lives, particularly during their childhood years. Second languages are not acquired, and the experience of living in other countries, or even visiting them on more than a superficial plane, is rare. International leisure travel is beyond the financial grasp of most children as they grow up. Yet these young men and women will have to work in a highly global environment when they reach adulthood.

●The face of America is changing and changing rapidly. Our minority populations will continue their rapid growth in the next generation. We are experiencing immigration from the east and south on a scale comparable to the waves of Europeans coming to our shores early in the century. The range and extent of professional activity and leadership accessible to women continue to expand.

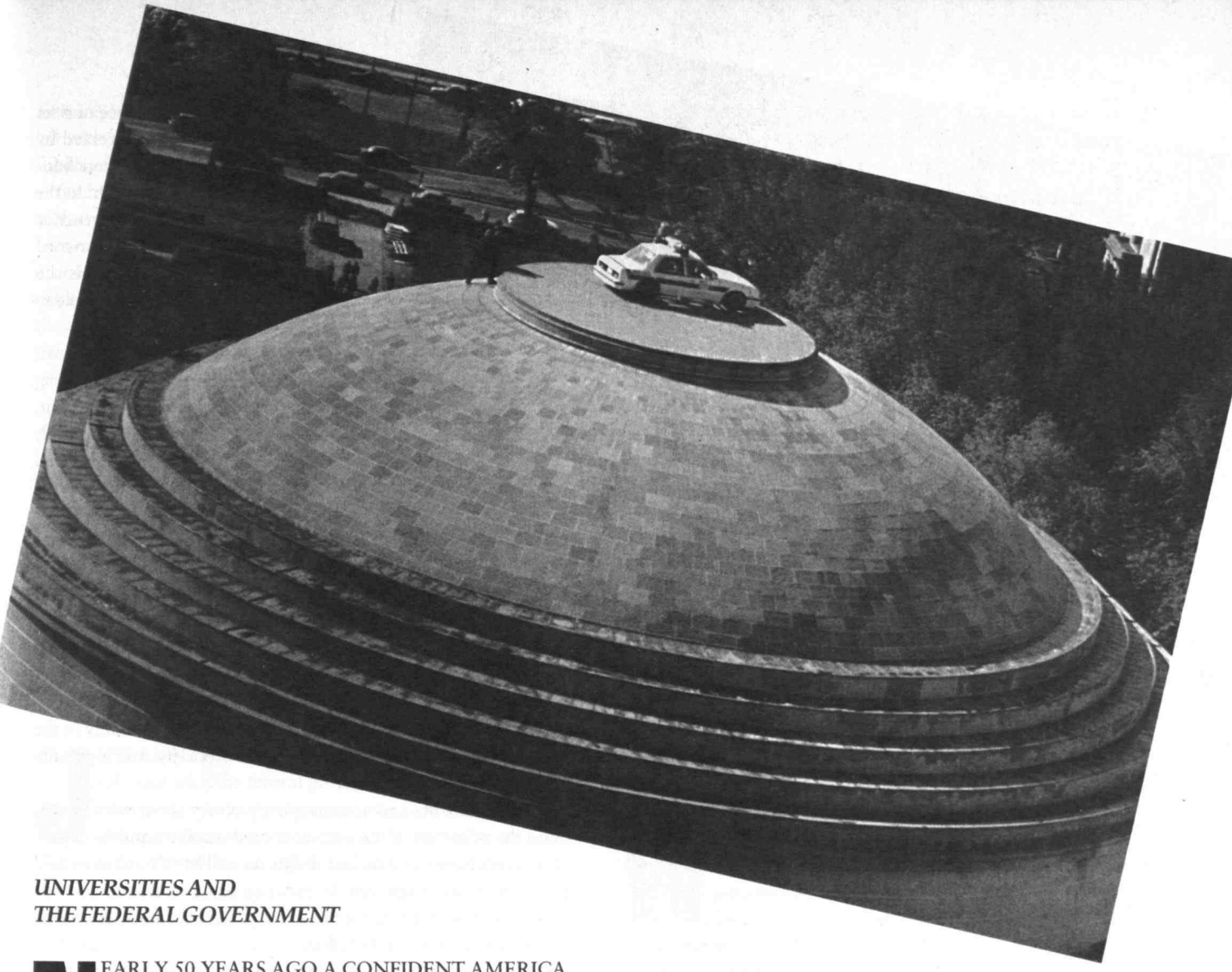
From these changing realities and contexts, a new agenda for universities must emerge – one that will emphasize their contributions to civilian issues: improving health and welfare; creating industries and societies that are sustainable in terms of energy and environment; increasing quality and productivity in both manufacturing and service industries; understanding the origin, development, and reduction of violence; establishing and replenishing our physical and information infrastructures; and preparing students to live, work, and exercise leadership in an increasingly international context.

THE MISSION OF HIGHER EDUCATION

THE CENTRAL MISSION OF UNIVERSITIES IS TO educate students. Drawing on the German model, America added to this mission the generation of new knowledge. In the period since the Second World War, we continued this evolution to create the uniquely American research university. At their best, these institutions are communities of learning that respect the intrinsic value of new knowledge and understanding, while at the same time emphasize the importance of interacting with and influencing the world beyond campus boundaries. The nature and raison d'être of these communities are generally well understood and held in common by their members.

The external perception of the universities' mission, however, is increasingly unclear. For many decades both the public and governments held a fairly common understanding that the underlying role of education in America at all levels was to prepare citizens to operate a democracy. This essentially Jeffersonian view has served the nation well, bringing a commitment to education for all citizens, and a healthy mingling of practical education with humanistic, artistic, and scholarly endeavors. It provided the fertile soil that supported the growth of the post-Civil War land-grant universities and the post-World War II research universities. There now is a great sense of turbulence and uncertainty that suggests that some new educational form will emerge in this immediate post-Cold War era. At the least, the social contract among the taxpaying public, and the private, governmental, and academic sectors will be rewritten.

PHOTO ON PROCEEDING PAGE: MARK ALTBUSH



UNIVERSITIES AND THE FEDERAL GOVERNMENT

NEARLY 50 YEARS AGO A CONFIDENT AMERICA, seeking to build a strong future for its citizens, established an approach to advancing science, technology, and education that is unique in the world. The government, noting the critical role that university faculty and researchers had played in World War II, turned to the universities to conduct the basic research that would undergird our national goals.

For half a century, federal agencies have funded research and graduate education programs that have been uncommonly successful. Federally supported university research has generated essential components of our technology base, produced new generations of scientists and engineers, and driven the economy in important ways.

Federal spending at research universities was viewed as an essential investment in the future. The economic payback on this investment is hard to determine, but in recent decades, the economic analysis of University of Pennsylvania economist Edwin Mansfield suggests that the annual rate of return on investment in academic research is on the order of 25 – 30 percent. The Congressional Budget Office reviewed this analysis and concurred with this estimate of the remarkable rate of economic payback to the country on its investment in academic research. Nonetheless, the public and the Congress now increasingly question the value, priority, and relevance of this investment. The sense of partnership between government and universities has decayed dramatically.

Establishing a renewed partnership and common vision requires that we look forward, not backward, and face the challenges of a new era. It requires that we set a good balance between immediate national needs and the long-term good of the country. It also requires that we recognize the increasing scale, cost, and complexity of research. But above all, it requires that we establish a sense of common purpose.

A key mechanism for setting the tone of the evolving relationship and nature of federal support of higher education is the establishment of national research policy. Once the relatively clear domain of the executive branch, such policy is increasingly set in Congress through the appropriation process. This makes the job of establishing purpose and commitment much more difficult.

In an event that probably rivaled the 1994 Nobel Prize to MIT physicist Clifford Shull—in media attention, anyway—student hackers installed what certainly looked like a Campus Police car on the roof of the Great Dome in May. It was actually the shell of a car, but it was "fully equipped" with a synthetic officer and genuine coffee and donuts. *(See class of '49 notes, page MIT 27, for more details.)*

PHOTO: BOSTON GLOBE

The editors of the 1994 Technique *know an irresistable photo when they see one: Alice and Julia Song, both Class of '94.*

America knows better than any other nation *how* to do research, but we have lost our common understanding of *why* to do research.

Our national R&D pendulum swings fast and wide. We commit the nation to advance fundamental physics by constructing the Superconducting Supercollider, spend $2 billion, and then decide not to do it after all. We declare that industrial policy or even technology policy is verboten, then within a couple of years we commit to a national clean car initiative organized by the Department of Commerce. National laboratories, mostly dedicated to weapons production and accustomed to noncompetitive, steady funding, suddenly aim to become adept at assisting industry. And in industry itself, central research laboratories with a strong commitment to basic research have for the most part been transformed into organizations with entirely different missions.

These swings are manifestations of the vagaries of our political system, but they also are indicative of an unstable search for policy in a time of fundamental change. Synergy and common understanding among the universities, the federal government, and industry have been lost. They must be regained.

BALANCING THE SHORT AND LONG VIEWS

A MAJOR ISSUE FOR THE FUTURE OF RESEARCH universities will be the emerging federal view of the proper balance between clearly applicable research and the fundamental pursuit of the unknown. Ignoring fundamental research is just another way of living for the short term at the expense of future generations. How to develop this balance and how to continually renew and draw fully on the talents and expertise of our faculties are the essence of a set of questions that must be addressed by those who establish policy in America for science, technology, and research. In the final analysis, establishing congruence between the driving passions of researchers and societal goals is the central issue of science and technology policy.

The last several years have seen considerable angst and strain among universities, the federal government, and industry regarding the nation's research and development profile, policies, and in particular the role of academia. We have begun to think about research in new and often unfamiliar terms. Some would turn rapidly to highly applied research, redirect the activities of scientists and engineers, and increasingly foreordain the specific directions of scientific research and technological investigation. After all, the argument goes – with considerable validity – Congress and the American taxpayer expect a strong return on their investment, preferably in the form of measurable improvements in our economy, and especially in high-wage employment.

Such arguments and actions greatly worry those who understand the dynamics of science, its unpredictability, and its dependence on curiosity and sudden insight as well as on hard work and a supportive environment. In order to prosper, and to provide maximum long-term benefit to society, science needs flexibility, continuous support, and passion.

These conditions are endangered by the current state of federal/academic relations. The past few years have seen a continuing attempt on the part of both Congress and the Administration to shift substantial portions of the cost of conducting university research away from the federal sponsors of that research. Rather than reimbursing universities for the full cost of the research conducted on our campuses, the government has expected the universities to shoulder more of those costs. This means using our tuition, gift, and endowment revenues to cover unreimbursed costs of federally sponsored research. At MIT, such changes already account for a recurring, annual shortfall of $10 million in federal reimbursement of actual and legitimate costs of research. There is a continual stream of further actions to arbitrarily cap reimbursement or otherwise undermine the support of our nation's research.

For example, this year the House of Representatives passed an appropriations bill that would have instantaneously decreased Department of Defense support of research at universities to 40 percent of its current level. The potential damage of this was imponderable. This is the primary source of federal support of engineering graduate education and research in the United States. It supports over 75 percent of all electrical engineering research on our campuses, and it accounts for approximately 50 percent of research in other critical fields such as mechanical engineering, computer science, materials science and engineering. Only at the eleventh hour during

PHOTOS: YUEH Z. LEE, '95

a Senate-House conference was this cut modified, but we still were left with a destructive 14 percent cut – a $200 million reduction in funding for DOD sponsored research on the nation's campuses.

Such instances have caused the university community to work with great intensity to promote understanding of the issues by members of Congress and their staffs. We have enlisted the help of leaders of American industry to explain the disastrous consequences to our economy and competitiveness. In the process of fighting each of these difficult, defensive political battles, the universities have had to divert enormous time and effort from our primary mission of education and research.

We are in the midst of an increasingly vicious cycle of Congressional attack followed by intense defensive efforts by universities to create withdrawal or compromise. As we try to make our case, however, we are increasingly chided for acting like lobbyists, a role with which we are distinctly uncomfortable. Yet when push comes to shove, a common complaint by members of the Congress when an issue arises is that we haven't been paying enough attention to them. This is not a stable way to conduct federal policy. This is a time of both change and financial stress that calls for reasoned development of policy.

UNIVERSITIES AND INDUSTRY

JUST AS WE ARE IN THE MIDST OF CHANGE IN OUR relations with the federal government, so too are relations with private industry changing. Much of this is driven by the rapid changes in industry itself. The end of the Cold War, combined with the incredible rate at which electronic communication is expanding, and the irreversible globalization of competitive businesses have led to radical transformations of industries and organizations. This is accelerated by the expanding knowledge base that is giving rise to entire new industries such as biotechnology. Work is being accomplished in new ways as products are completely defined digitally before they exist physically, as so-called agile organizations are formed by electronic links among component groups throughout a company, or more likely among large and small groups spread around the world. Although the emerging forms of organization are not yet clear, it is certain that students need different preparation to enter this new work environment.

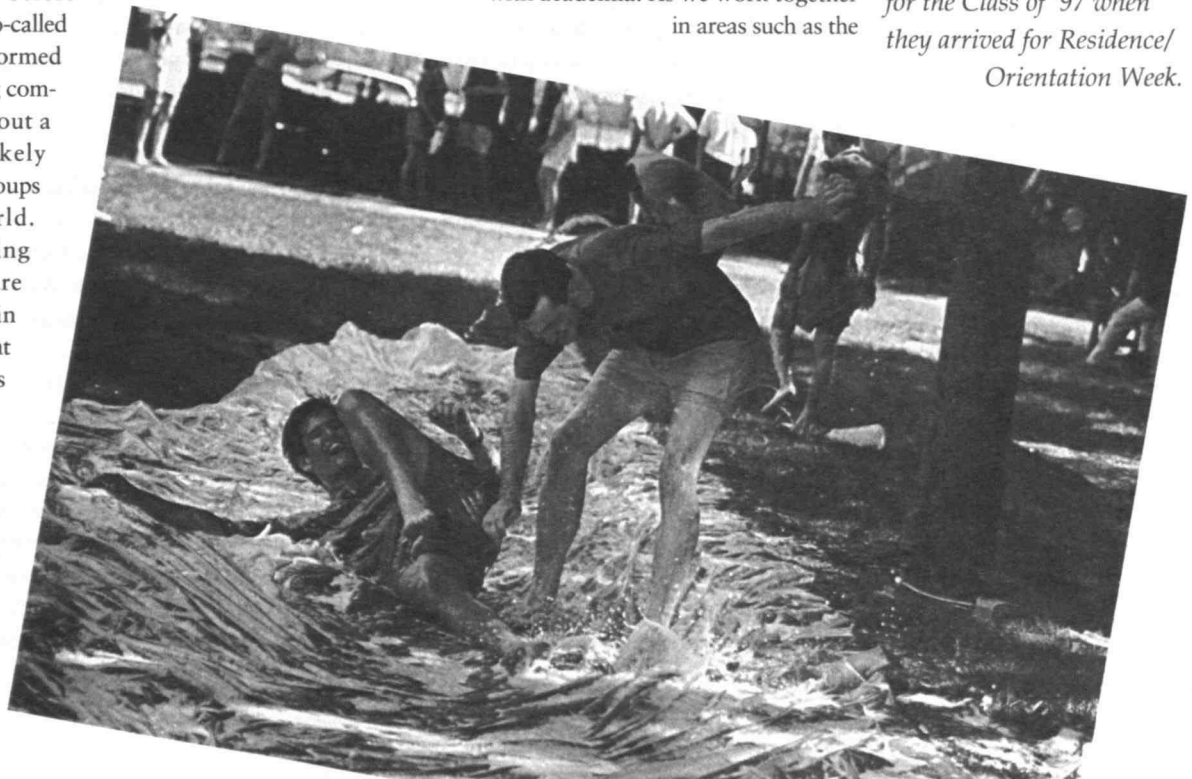
For the research universities, this situation is full of opportunity and responsibility, but also of danger. I believe that the opportunity and responsibility greatly outweigh the danger, particularly for MIT, which was founded to create a strong, even unique, relationship with industry. The opportunities and responsibilities are clear: an exciting new, intellectual, and educational agenda needs to be forged, especially in engineering and management. The dangers are equally clear: universities run the risk of assuming an overly utilitarian role, and the crucial openness of academic dialogue could be lost through ill-conceived policies regarding intellectual properties and dissemination of new knowledge.

The history of interaction of industry and academia has been mixed, and there have been major roadblocks of cultural differences and arrogance on both sides. We too often have passed as ships in the night, not really listening to or understanding each other. This is changing. Industrial issues have become intellectually challenging and exciting from the perspective of faculty and students, and, indeed, we need each other as never before.

The intellectual agenda of MIT and some other universities is evolving as new technological issues arise and as we attempt to understand and define new organizational structures. This can only be done by increasing the breadth and depth of dialogue and partnership with private industry, as well as with government. It can only be done if it is strongly supported both financially and intellectually.

POTENTIAL CLASHES BETWEEN INDUSTRIAL AND ACADEMIC VALUES

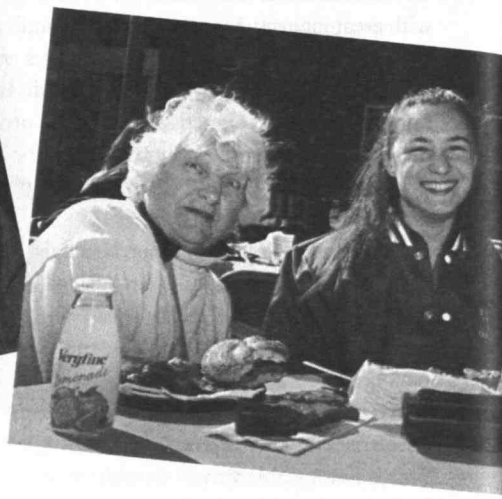
WE MUST TAKE GREAT CARE AS WE DEVELOP new relations with industry, however, that universities not assume a posture that is too utilitarian. In time this would erode their intellectual independence and their ability to serve as objective critics of society. Indeed, there is a paradox in that it is this very independence and objectivity that usually attract industry to work jointly with academia. As we work together in areas such as the



This East Campus water slide was one of the attractions available for the Class of '97 when they arrived for Residence/ Orientation Week.

environment, energy, telecommunications, and productivity that have policy implications, we must maintain our independence and objectivity. Thus it is in the best interests of both parties that these matters be addressed carefully and resolved.

Another area of potential clashes of industrial and academic values is intellectual property. Universities hold dear their role in discovering and disseminating knowledge. The underlying assumption is that what we do on our campuses is, or should be, of general value to society and should be shared openly to advance humankind. In addition, many universities maintain unrealistic expectations about "striking it rich" through patent royalties and have tended to be overly protective and difficult when it comes to negotiating sponsored research agreements.



Family Weekend '94: relatives and friends accompanied by "their" student, everybody in festive mode. Thirty-four academic departments, labs, and administrative offices opened their doors to 1,350 Family Weekend attendees. There were games in Strobe Alley, a talk on the comet hitting Jupiter, and MIT clobbered Curry College at football, 48-0.

Companies, on the other hand, must compete to create value for their customers and financial gain for their stockholders. Therefore they have an interest in holding closely both the knowledge and techniques that give them a competitive advantage. Patent ownership is a tool for protection of their competitive advantage, for maximizing profits by charging for their use, and for avoiding having to pay royalties to others, including universities.

Why has the matter of proprietary knowledge and patent rights become so controversial? First, there are simplistic understandings of what constitutes technology transfer. This has been particularly visible in debates about university interactions with non-US based companies, where it sometimes is assumed that university scientists and engineers generate highly specific devices and ideas that are the immediate "silver bullets" to create consumer products. Although this may be the case in rare instances, it generally is not. In fact, the most important mechanism for technology transfer from universities, and from companies for that matter, is educated and trained people and their broad-based knowledge and know-how.

Second, the time from fundamental discovery to commercialization has decreased dramatically in many fields, and margins of competitive advantage have become very small and fleeting in many fast-paced industries. It also must be recognized that views on this topic seem to vary, largely based on the maturity and scale of the industry in question. It also generally is the case that discussions with industry leaders at the highest ranks within corporations seem to be much more flexible than with those at the operating level who are involved with making project level decisions.

MIT's current approach to patents is designed to encourage the transfer of technology to the private sector. This requires an ability to negotiate with industrial sponsors as equals, best accomplished in our view, by ownership of intellectual properties produced by campus researchers coupled with flexibility in reaching agreements with sponsors about licenses.

A final debate should be noted that may indeed prove to be much more complex than those discussed above – intellectual properties and copyrights in the emerging world of digital information systems. The knowledge base used for both scholarly and commercial pursuits is rapidly becoming stored, disseminated, and operated upon in digital form. Knowledge bases are increasingly created electronically by individuals and organizations dispersed both geographically and temporally. This raises very fundamental and difficult questions about ownership and access to knowledge. It is made worse because our system of copyrights and patents is an archaic one based on a world in which the printed page was the only information carrier. When coupled with the regulatory environment within which the rapidly emerging worldwide information highway and distributed digital library must operate, we will face some very interesting questions, that again may place universities and industries in debate.

RESPONSES TO A NEW ERA

IN AN ERA IN WHICH ECONOMIC, POLITICAL, DEMOgraphic, scientific, and technological changes occur at breathtaking speed, there are extraordinary opportunities for industry, government, and academia to regenerate themselves and to forge new alliances. Indeed, industry already *is* changing very rapidly; our federal government's R&D policy *will* change; and higher education, especially in engineering and management, *must* change.

PHOTOS: J.D. SLOAN

INDUSTRY'S RESPONSE

AS AMERICAN INDUSTRY HAS FACED CHALLENGES of unprecedented intensity to its ability to compete in the world marketplace, the goal of its R&D establishment has changed to concentration on relevance to commercial interests and reduction of product cycle times. The great industrial research laboratories that primarily conducted relatively basic research in areas of long-range potential to their companies have nearly disappeared. Industrial R&D groups must now clearly and continuously justify their importance to the company's business. This has had some salutary effects. After radical restructuring and clarification of missions, many industrial R&D groups are showing renewed vigor, are developing vastly improved interdisciplinary capabilities to improve goods and services, and are stimulating new commercial successes.

These changes create two potential problems. The first is a lack of investment in mid- to long-term research. The second is the danger that communication across company and campus boundaries will be choked off.

Today's technological advances are generally very complex, and we must have a broad understanding of how the entire system of research and development evolves and advances. A company that makes power generation equipment, to pick an example, depends upon an extended R&D infrastructure that, over time, has produced knowledge of combustion and fluid mechanics, computers and software for simulation and design, advanced materials, and many other techniques and entities largely developed under sponsorship by the government, often with long-range military needs in mind, or in industrial research laboratories of a type that hardly exist any longer. Much of the nation's traditional strength in industrial research that is relatively fundamental, yet has a strong potential for industrial applicability, is rapidly eroding, replaced with narrowly-defined, company-specific R&D. Despite the improvements in competitiveness of individual companies that their transformed R&D organizations have greatly aided, we must recognize that a system that emphasizes short-term gain, promotes local secretiveness, and discourages open interaction across company and university boundaries, will lose the momentum needed for the long-run good of the nation.

As their economic positions improve, corporations will need to increase the fraction of earnings devoted to research, and they will need to direct some of this into mid- to long-term research. Once industries become productive and cost competitive, and achieve high quality levels through concentration on process, they will enter a next round of competition that will require new levels of innovation and design. This, in turn, requires generation of, or access to, advancing scientific and technological knowledge. Companies have an obligation to produce some of this new knowledge, but also to participate in a national, or perhaps global, R&D infrastructure. They no longer can take for granted either the extended system of federally sponsored, university-based research or the major industrial research laboratories that have provided such advances for the last four decades. It is essential that we experiment with substantial new forms of R&D partnerships among industry, universities, and government. Joint projects, new forms of consortia, industrial laboratories adjacent to campuses, and new research agendas will be required to create a new R&D infrastructure for the post-Cold War era.

As industry establishes new research and educational partnerships with universities, technology transfer from universities to the private sector will continue to be an important concept. This has an honorable genesis in the land-grant universities that created agricultural experiment stations and county agent systems for the development and dissemination of applicable scientific knowledge to the nation's farmers. Openness of agricultural research results was central to this system, but contemporary technology-based partnerships pose significant issues about dissemination of research results.

We must carefully consider the matter of patents and openness. The situation requires thought from a systemic and long-range perspective. What, in the long run, will serve all parties well? Because of the need to maintain the extended R&D infrastructure, the issue of rebalancing competition and cooperation lies at the center of consideration of policy toward patents and proprietary research on campuses. We must minimize secretiveness and overly protective patent policies on the part of companies sponsoring research or otherwise working in partnership with research universities.

GOVERNMENT'S RESPONSE

FEDERAL POLICY MUST RESPOND IN TWO WAYS. First, it must assure strong funding for truly fundamental research. This is the long term investment, the patient capital that is essential for the benefit of our children and their children. Second, the government should work in partnership with

Given the need—forcefully expressed in this report—for U.S. research universities to both understand and influence public opinion, Family Weekend offered MIT President Charles Vest (second from left, with his wife, Rebecca) an opportunity to interact with an important public constituency: the parents of students.

private industry and academia to identify those areas of technological advancement that are most critical to the well-being of the nation. Once identified, broad goals should be set for them. Tasks must not be dictated in detail, but general strategic directions should be set and wide bands or pathways in which research scientists and engineers can pursue their efforts should be defined. There must be room for the free market of ideas.

In order to be a great nation, we must press onward with our commitment to support fundamental research and the people and institutions that enable it. History shows that advancement of knowledge, beyond its intrinsic value, does indeed lead to advances in health, productivity, learning, and quality of life. It is the foundation on which progress is built. If we in America do not pursue fundamental research along uncharted pathways, others will. Indeed, others should. All nations that aspire to excellence and advancement of the human condition should strongly support basic science.

Yet, we also know the facts. There are identifiable, strategically important areas of science and technology that we must master and advance in order to improve or even maintain our industrial competitiveness. This is true, notwithstanding the fact that with greater freedom, scientists and engineers will discover and invent new, as yet undreamed of and even more important technologies.

It would be suicidal to dictate what all researchers should work on and to set simplistic goals for immediate commercial application of all that they do. It will not work. The futility of state planning brought down the Berlin Wall. But, it is entirely appropriate to foster a new commitment to solving the problems of our era – the civilian concerns that the end of the Cold War frees us to address, and that are essential to the well-being of the next generation. This is challenging and exciting. Appropriate areas are rather easy to define: the environment, energy, transportation, our telecommunications and computing infrastructure, and more livable cities, to name a few.

RESEARCH UNIVERSITIES' RESPONSE

THE NECESSARY RESPONSE OF UNIVERSITIES lies partly in their research programs, but even more importantly in education *per se*. We must strive to be sure that research universities fulfill their promise as learning environments remarkably well suited to the coming era – in which undergraduates, graduate students, and faculty alike share in the discipline, joy, and continual renewal of original research and scholarship. Our research orientation enables us to lead the way in education, because society will ask much more of our graduates than that they know what others have accomplished in the past. If our students are to reach their full potential to contribute to society and, just as importantly, to enjoy fully the beauty and the adventure of creating and understanding, we have to teach them how to advance knowledge.

In addition, the increasing complexity of tasks that will face our graduates means that we must better prepare our students to understand how to draw on knowledge from many different disciplines, how to contribute as members of teams as well as individuals, and how to communicate with members of the public, government or business community, as well as with their professional colleagues.

Beyond that, we must take greater responsibility for helping students to develop broader world views and the expertise required to live and work in a more global context. This responsibility extends beyond the classroom and laboratory to the nature of our student body and faculty itself. We must be unflagging in our efforts to be accessible to and inclusive of all of our talented young men and women. Indeed, most of us can point with considerable pride to the diversity of our undergraduate student bodies, accomplished through a great deal of hard work in the 1970's and 80's. Yet we still have much to do to build the diversity of our graduate student populations and our faculties, and to successfully draw together the increasingly diverse talents and cultural perspectives of our faculty and students around a common set of basic values and purposes.

This need to explore and understand "real world" complexities and organizations requires that we must work more in partnership

PHOTO: YUEH Z. LEE, '95

with industry. Specifically, we need to bring engineering and management closer together in the education of industrial and societal leaders. Academia and industry should work together to bring about a greater common understanding of industry's needs and the university's educational role in fulfilling them. Of course, we should discount ideas that are relevant only to the current moment and keep focused on the long-term good.

Researchers and engineers from industry and university faculty should spend significant time in each other's domains in order to undertake cooperative projects, both basic and applied. This could become a remarkably effective mechanism for technology transfer. There are substantial roadblocks to doing so. Faculty feel that they cannot leave their posts for a year because they will not be able to maintain the momentum of their research projects. Outstanding engineers in industry believe that they will fall off their career path if they leave their current responsibilities for a year. Surely this problem is solvable if companies and government funding agencies would make a concerted effort to enable such exchanges. Let's get serious about this. Every other country in the world seems to encourage and reward first-rate engineers and scientists for spending time as visiting researchers in American universities.

Another further step is for colleagues in university and industry to work closely together to design the engineering and management education programs of the future and to discuss research agendas. MIT has taken a number of steps to ensure a good dialogue among faculty and industrial leaders and to complement the ongoing activities of our Industrial Liaison Program and various research consortia. In September of 1993, MIT held, in conjunction with the World Economic Forum, an Industry Summit that attracted over 800 high-level leaders of industry and government from around the nation and world to discuss issues facing industry and to explore solutions to them. In addition, during the past academic year, an Institute Task Force on Industry Linkages has been considering and making recommendations regarding the appropriate relationships between MIT and industry for the coming decade.

At MIT we have a special obligation to educate engineers, managers, and scientists who can lead in this changed milieu. Our greatest challenge in this regard is to develop in our students the *attitudes,* as well as the aptitudes, needed to translate new knowledge from research to practical ends.

INVESTING IN THE FUTURE

KNOWLEDGE AND A POPULATION EDUCATED and skilled in ways that permit its creative use are the capital resources of the emerging era. Knowledge, not natural resources or geographic location, will determine which nations and societies prosper. Knowledge is distributed throughout organizations and societies; and we must learn to utilize it collectively and effectively. Knowledge will increasingly be gleaned by computer networks from far-flung sources, shaped by collaborative efforts, moderated by information technology. Knowledge can only be generated and wisely used by educated and inspired people. The generation of new knowledge requires commitment to, and investment in, research.

Universities are our primary vehicle for educating talented men and women and for producing new knowledge, insight, and techniques. In order to serve well, universities must balance continuity and change. Continuity of their deeper values, guiding principles, and commitment to intellectual excellence and the life of the mind are essential. Yet so is a willingness to change, experiment, and improve. America's colleges and universities are changing in response to the new era – changing too slowly, perhaps, but profoundly. A walk across MIT's campus will disclose a student body radically different from that of 20 years ago, one increasingly rich in its racial and cultural makeup, reminding us again that our country is changing rapidly and that we still are a nation of immigrants, as we always have been.

Our curricula are shifting to meet new needs, challenges, and opportunities. All MIT students now must learn cellular and molecular biology. Master's-level education in our Schools of Engineering and Management is being altered and integrated. New international university/government/industry partnerships are being formed to conduct objective studies of environmental issues and create sound policy alternatives. New programs are emerging – ranging from fundamental studies of mind and memory to new product development and manufacturing. New linkages to industry are forming. Yet much more remains to be done as the intellectual agenda for the post-Cold War era and a new economic citizenship emerge. We have only scratched the surface of using information technology and multimedia to create new and more effective ways of knowing and learning. We have only begun to understand what is required to prepare our students to cooperate and compete across national and cultural boundaries.

Universities like MIT must become more cost effective and improve the quality of all that they do as organizations and learning communities. Many view us as clinging to the past, unwilling to change and improve. We must regain the public trust if we are to realize our aspirations and serve the future as we always have. This requires that we change substantively, becoming organizationally still more lean and effective. We have started to re-engineer many of our administrative and service activities to become more cost effective, productive, and efficient. We must lead in this effort just as we lead intellectually. Only in this way will we remain financially accessible to those we must educate.

But we cannot escape the fact that the nation must continue to invest in its system of higher education and research. The federal government must stop the trend of shifting the cost of research it sponsors to tuition, gift, and endowment funds. Private industry must work with us, and invest in us, to ensure the health of the nation's research and development by supporting us intellectually and financially in new ways.

The dreams and visions of our institutions and our students will not be fully realized, and the nation and world will not fully benefit from our potential, unless a renewed commitment to education and research is forged and widely held by the public. This is not a matter of luxury – it is a matter of regaining pride and belief in our people and their future.

CHARLES M. VEST
October 1994

STATISTICS FOR THE YEAR

REGISTRATION

In 1993-94 student enrollment was 9,790, compared with 9,798 in 1992-93. There were 4,509 undergraduates (4,520 the previous year) and 5,281 graduate students (5,278 the previous year). The international student population was 2,196, representing eight percent of the undergraduate and 35 percent of the graduate populations. These students were citizens of 101 countries. (Students with permanent residence status are included with US citizens.)

In 1993-94, there were 2,757 women students (1,528 undergraduate and 1,229 graduate) at the Institute, compared with 2,722 (1,506 undergraduate and 1,216 graduate) in 1992-93. In September 1993, 369 first-year women entered MIT, representing 34 percent of the freshman class of 1,081 students.

In 1993-94, there were, as self-reported by students, 2,417 minority students (1,905 undergraduate and 512 graduate) at the Institute, compared with 2,271 (1,806 undergraduate and 465 graduate) in 1992-93. Minority students included 346 African Americans (non-Hispanic), 41 Native Americans, 478 Hispanic Americans, and 1,552 Asian Americans. The first-year class entering in September 1993 included 502 minority students, representing 46 percent of the class.

DEGREES AWARDED

Degrees awarded by the Institute in 1993-94 included 1,092 bachelor's degrees, 1,230 master's degrees, 31 engineer's degrees, and 516 doctoral degrees – a total of 2,869 (compared with 2,812 in 1992-93).

STUDENT FINANCIAL AID

During the academic year 1993-94, an improving economy helped reduce the rate at which the demand for financial aid continued to climb, while increased contributions to the scholarship endowment and income from outside scholarship support helped to meet the need for grant funds. A total of 2,660 students who demonstrated need for assistance (54 percent of the enrollment) received $32,861,000 in grant aid and $12,677,000 in student loans from all sources. The total, $45,538,000 represents a 6 percent increase in aid compared to last year.

Grant assistance to undergraduates was provided by $9,724,000 in income from the scholarship endowment, by $1,064,000 in current gifts, by $3,740,000 in federal grants (including ROTC scholarships), and by $2,810,000 in direct grants from non-federal outside sources to needy students. In addition, $15,523,000 in scholarships from MIT's unrestricted funds was provided to undergraduates, inclusive of the special program of scholarship aid to needy minority group students, which represented $505,000, and the MIT Opportunity Awards, which accounted for $794,000. An additional 468 students received grants irrespective of need from outside agencies, totaling $2,187,000. The undergraduate scholarship endowment was increased by the addition of $4,788,675 in new funds. These new contributions increased the endowment for scholarships by 6 percent to $86,981,404.

Loans totaling $12,677,000 were made to undergraduates, a 14 percent increase from last year. (This increase reflects the 34 percent increase in Federal Stafford Loans resulting from expanded eligibility criteria and increased loan limits under this program.) Of the total loans made, $1,324,000 came from the Technology Loan Fund, $3,032,000 came from the Federal Perkins Loan Program, and $8,321,000 came from the state-administered Stafford Guaranteed Student Loan Program and other outside sources.

Graduate students obtained $2,120,000 from the Technology Loan Fund. In addition, $236,000 was loaned by MIT under the Federal Stafford Guaranteed Student Loan Program. The total, $2,356,000, is a 3 percent decrease from last year's level. Graduate students obtained $3,585,000 from outside sources under the Federal Stafford Program, 14 percent more than last year and $1,843,000 from Federal Supplemental Student Loans and other outside sources. Graduate students also received $11,000 in Perkins Loan funds. The total, $7,795,000 is an increase of 5 percent over last year.

The total of loans made to undergraduate and graduate students was $20,472,000, an 11 percent increase over last year.

The improving economy helped to slow the rate of increase in the number of needy undergraduate students and the average need. The number of needy students remained almost the same as last year, increasing by only 8 students to 2,660. The average need for this population increased by 6 percent to $18,761. In the aggregate, the financial aid program required $23,241,000 from needy students' family resources and provided $49,907,000 in aid dollars including work programs. As in past years, the aid program provided more than two-thirds of needy students' total costs.

CAREER SERVICES AND PREPROFESSIONAL ADVISING

In spite of some significant industries doing very little hiring – among them aerospace, automobiles, oil, and chemicals – recruiting at the Institute continued to hold up well. Three hundred and ninety-three separate employing organizations conducted interviews in the central careers office, up from 382 the previous year. As in 1992-93, firms selling non-material products and services were responsible for much of the recruiting activity. This year almost 42 percent of the organizations recruiting on campus were software firms, consulting firms of various sorts, or banks. The financial industry was second only to civilian electronics in the number of organizations conducting interviews. It is too soon to say whether the service sector attracted a comparable percentage of the students entering employment, but student interest ran high, at all degree levels. Students completing degrees in the natural sciences and engineering no longer see themselves as necessarily committed to careers in technology.

Salaries showed very little change from 1992-93, except at the master's level in some fields.

The number of MIT applicants to medical school continued to increase. One hundred and sixty students and alumni/ae used the services of the Institute in filing their applications, up from 143 in 1992-93. The Association of American Medical Colleges reports that there were as many 201 MIT candidates in all. The last time MIT candidates applied in such numbers was 20 years ago, in the aftermath of the Vietnam War.

GIFTS

Gifts, grants, and bequests to MIT from private donors in 1993-94 totaled $94.6 million. This amount includes cash, securities, and

PHOTOS: MIT NEWS OFFICE/DONNA COVENEY

real estate gifts totaling $86.8 million, and $7.8 million in support through the Industrial Liaison Program. In addition, gifts in kind, mostly of equipment, totaled $6.1 million. The gifts reported by the Alumni Fund were $23.0 million, a new record.

Payments on pledges and significant new commitments continued to be received following the end of the successful *Campaign for the future* on June 30, 1992. Major efforts are continuing to increase endowment for student financial aid, faculty support, academic initiatives, new and renovated space, and unrestricted funds.

Professor Emeritus Clifford Shull won the 1994 Nobel Prize in physics for pioneering work he did almost 50 years ago on neutron diffraction. He shared the prize with Professor Bertram Brockhouse, of McMaster University in Canada, who developed the technique of neutron spectroscopy. "In simple terms, Clifford Shull has helped answer the question of where atoms 'are' and Bertram Brockhouse the question of what atoms 'do,'" the Royal Swedish Academy said in announcing the prize. As Shull's wife, Martha, astutely commented, "People kept winning [the prize] based on the work he did, so I just figured they ought to have given it to him one of those years."

FINANCES

As reported by the Vice President for Finance and Treasurer, the total financial operations of the Institute, including sponsored research, amounted to $1.14 billion – an increase of 0.5 percent from 1992-93. Education and general expenses – excluding the direct expenses of departmental and interdepartmental research and the Lincoln Laboratory – amounted to $560.7 million during 1993-94 compared with $542.1 million in 1992-93. The direct expenses of departmental and interdepartmental sponsored research on campus increased from $259.2 million to $263.3 million, while direct expenses of the Lincoln Laboratory sponsored research decreased from $332.6 million to $315.5 million. Current revenues used to meet the Institute's operating expenses totaled $1.13 billion, augmented by $6.2 million in current gifts, $1.9 million of other fund balances, and $4.3 million of funds functioning as endowment.

At the end of the 1994 fiscal year, the Institute's investments, excluding retirement funds, student notes receivable, and amounts due from educational plant, had a book value of $1.8 billion and a market value of $2.15 billion compared to last year's book value of $1.6 billion and market value of $2.13 billion.

PHYSICAL PLANT AND CAMPUS ENVIRONMENT

Concern for the safety of those who work, study, and reside on the MIT campus continued to be a high priority. New campus lighting along Memorial Drive and in Killian Court was installed for improved visibility, card readers were put in place at the Westgate and Vassar Street parking areas for tighter access control, major safety and security-related improvements to the Albany Street Garage were initiated, and card access control replaced exterior door key control in most of our dormitories.

During the year, many renovations and physical improvements were undertaken across the campus. Construction began on the Tang Management Center, and the Cambridge City Council granted permission to construct a pedestrian bridge over Ames Street to connect the Tang Center, when completed, with the Muckley Building (E40). Construction continued on the Cogeneration Plant, with completion projected for late next winter. Major renovation projects were initiated in Building 3 (the Pappalardo Mechanical Engineering Laboratory); Buildings 3, 5, 7, and 10 (Architecture); W2/2A (conversion to dormitory spaces); W11 (the Religious Center); and the E17 Animal Facility.

Two projects were completed this year, the Biology Building (Building 68) and the CASPAR (Cambridge and Somerville Program for Alcoholism and Drug Abuse Rehabilitation) Emergency Service Center at 240 Albany Street. The Biology Building, a 247,250 square foot facility, is a state-of-the-art building with office space, conference rooms, laboratories, and animal facilities. Ground was broken for the CASPAR Center, a 55-bed rehabilitation facility, in October. Despite difficult winter weather conditions, it was completed and occupied in the late spring.

The Institute purchased a town house at 478 Commonwealth Avenue in Boston for the purpose of providing a chapter house for the MIT Chapter of Alpha Chi Omega Sorority. Renovation commenced immediately upon the closing of the sale, with occupancy anticipated for the start of school in the fall.

A group of individuals, all of whom are involved with the implementation of services in support of persons with disabilities, was convened in order to better coordinate on an ongoing basis the Institute's response to the Americans with Disabilities Act (ADA) and other related issues. ■

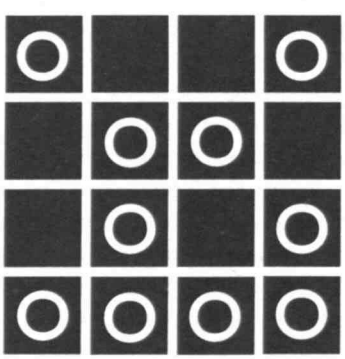
PuzzleCorner

This being the first issue of a calendar year, we again offer a "yearly problem" in which you are to express small integers in terms of the digits of the new year (1, 9, 9, and 5) and the arithmetic operators. The problem is formally stated in the "Problems" section, and the solution to the 1994 yearly problem is in the "Solutions" section.

Problems

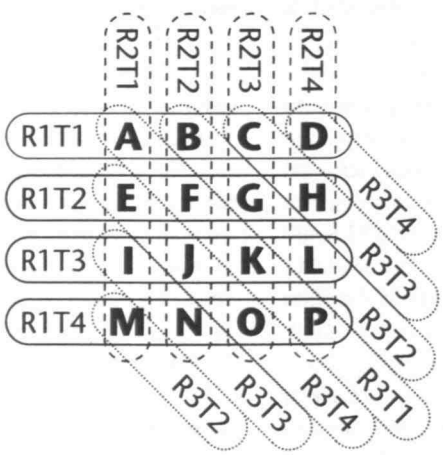
Y1995 How many integers from 1 to 100 can you form using the digits 1, 9, 9, and 5 exactly once each and the operators +, -, x (multiplication), / (division), and exponentiation. We desire solutions containing the minimum number of operators; and, among solutions having a given number of operators, those using the digits in the order 1, 9, 9, and 5 are preferred. Parentheses may be used for grouping; they do not count as operators. A leading minus sign does count as an operator.

JAN 1.



In the figure above the 10 circles are placed so that there are 10 rows, columns, and diagonal that each contain an even number (2 or 4) of circles. In 1928 Sam Loyd asked how to place the 10 circles so as to obtain the maximum number of rows, columns, and diagonals containing an even number of circles. Nob Yoshigahara, in the spirit of today's "less is more" generation, asks you to place the 10 circles so as to obtain the minimum number of rows, columns, and diagonals containing an even number of circles.

JAN 2. Jerome Dausman, a former U.S. Monopoly champion, was asked by Parker Brothers to judge a regional championship, which consists of three rounds of play each with four tables. When there are 16 contestants the following pairings are used.



(The oval R3T2 contains the players who are to sit at table 2 during round 3.) This solution has no player playing the same opponent more than once. There were 16 contestants at the championship Dausman was to judge so the decision was made to have two three-player tables and two four-player tables in each of the three rounds. An added requirement was that each player would sit at at least one three-player table and at least one four-player table during the three rounds. Find a set of pairings so that the number of players to meet an opponent more than once (a "second pairing") is minimized.

Speed Department

Speedy Jim Landau wants to know why manhole covers are always round.

Solutions

Y1994. The following solution is from Roger Claypoole:

1 = 1^994
2 = 1+(9/9)^4
3 = 94-91
4 = 1^99*4
5 = 1^99+4
6 = 19-9-4
7 = (19+9)/4
8 = 9-1^49
9 = 9*1^49
10 = 9+1^49
11 = (9-1)/4+9
12 = 9-1^9+4
13 = 14-9/9
14 = 19-9+4
15 = 14+9/9
16 = (1+9/9)^4
17 = 9*4-19
18 = 9*(4-1)-9
19 = 1^4+9+9
20 = (9*9-1)/4
21 = 9+9+4-1
22 = 1*(9+9+4)
23 = 41-9-9
24 = 19+9-4
25 = (1+99)/4
26 = 9*4-9-1
27 = 4*9-9*1
28 = 1-9+9*4
29 =
30 = 49-19
31 = (1+9)*4-9
32 = 19+9+4
33 = 99/(4-1)
34 =
35 = 9*4-1^9
36 = 1^9*9*4
37 = 1^9+9*4
38 =
39 = 49-1-9
40 = (19-9)*4
41 = 1-9+49
42 = 91-49
43 =
44 = 9*4+9-1
45 = (14-9)*9
46 = 1+9+9*4
47 =
48 = 49-1^9
49 = 1^9*49
50 = 49+1^9
51 =
52 =
53 =
54 = 9*(4+1)+9
55 = 19+9*4
56 =
57 = 49-1+9
58 = 99-41
59 = 49+1+9
60 =
61 =
62 =
63 =
64 =
65 =
66 =
67 = 9*9-14
68 = 49+19
69 =
70 =
71 = (9+9)*4-1
72 = 1*(9+9)*4
73 = 1+(9+9)*4
74 =
75 = 94-19
76 = (1+9+9)*4
77 = 1*9*9-4
78 = 91-4-9
79 =
80 = 9*9-1^4
81 = 1^4*9*9
82 = 1^4+9*9
83 =
84 = 94-1-9
85 = 99-14
86 = 1-9+94
87 =
88 =
89 =
90 = (1+4)*(9+9)
91 =
92 =
93 = 94-1^9
94 = 1^9*94
95 = 1^9+94
96 = 1+99-4
97 =
98 = 99-1^4
99 = 99*1^4
100 = 99+1^4

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO: ALLAN GOTTLIEB
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A/S 1. In a high-stakes game of rubber bridge with N-S vulnerable, West leads the Spade King against 6NT. Jorgen Harmse wonders what dummy should play to the first trick?

♠ A 3 2
♥ A K Q 7
♦ 7 6 5
♣ 5 4 2
N

S
♠ 5 4
♥ 6 3
♦ A K Q 4
♣ A K Q J 6

Oh, my. The "expected" answer is that you duck to set up all sorts of squeezes (the technical term used by responders was to "rectify the count"). But Matthew Fountain shows that giving up the potential overtrick is too high a price to pay to decrease the (already low) odds of being set. He writes:

Dummy should play the ace, when defenders' diamonds split 3-3 (probability = (6!/3!)(20!/10!/10!)/(26!/13!/13!) = .3553 and then neither defender has five clubs (probability = 1-(2)(15!/5!/10!)/(20!/10!/10!)=.9675), North's spade A and hearts A, K, Q plus South's four diamonds and five clubs add up to 13 tricks. The probability of N-S making one overtrick worth 200 points is (.3553)(.9675) = .344.

When one defender has five clubs (probability = (2)(21!/8!/13!)(26!/13!/12!) = .03913) and then diamonds do not split 3-3 (probability = 1-(6!/3!/3!)(15!/10!/5!)/(21!/13!/8!) = .7049), N-S has 11 sure trick winners. The worst that can happen is that N-S will be set one trick, for which the penalty is 100 points. This set has the probability of (.03913)(.7049) = .0276. Let M be the value in points to N-S for making 6NT with no overtrick. The expected value in points to N-S for making 6NT with no ace is played first is (1-.0276)M+(22)(.344)-(100)(.0276) = 66.04+(.9724)M. This expected value exceeds M if M is less than 2392. But M is no more than 1640, the sum of 190 points for six tricks beyond six, 750 points bonus for vulnerable slam, and 700 points for winning a rubber in two games. In short, there is no need to consider whether a play other than the ace will be safer in respect to making the bid. The value of the frequent overtrick offsets the rare loss of making the bid.

A/S 2. Frederick Furland wants you to show that two WRONGs can add up to a RIGHT (at least cryptarithmetically).

Eugene Sard makes the (moral?) assertion that "there are far too many WRONGs that add up to a RIGHT" and proceeds to list the following 21 solutions.

WRONG	RIGHT	WRONG	RIGHT	WRONG	RIGHT	WRONG	RIGHT
12734	25468	25173	50346	25734	51468	37806	75612
12867	25734	25193	50386	25867	51734	37846	75692
12938	25876	25418	50836	25938	51876	37908	75816
24153	48306	25438	50876	37081	74162	49153	98306
24765	49530	25469	50938	37091	74182	49265	98530
						49306	98612

He arrived at these solutions by expanding the equation 2(WRONG)=RIGHT in powers of 10, collecting like terms, and dividing by 20: N+10 O+1000 W=(T+10 H+98 G)/20+50 I+400 R. Since T+10 H+98 G must be a multiple of 20, there are 36 possible combinations of T, H, and G without duplication. Each of the 36 combinations resulting in 0, 1, 2, or 3 solutions. The only three-solution case is for G=8, T=6 and H=7, and completely illustrates the method. The original equation becomes N+10 O+1000 W=43+50 I+400 R. Therefore, N=3, and dividing by 10 yields O+100 W=4+5 I+40 R. Therefore, the two possible values of O are 4 and 9, yielding after division by 5: 20 W=I+8 R and 1+20 W=I+8 R, respectively. For O=4, the 5 non-duplicating available numbers are 0, 1, 2, 5, and 9, whereas for O=9, they are 0, 1, 2, 4, and 5. It is readily seen that for O=4, there is one solution W=2, R=5, and I=0, and for O=9, there are two solutions W=1, R=2, I=5 and W=2, R=5, I=1. Thus for this case the three WRONGs are 25438, 12938, and 25938, whereas the three RIGHTs are 50876, 25876, and 51876, respectively.

Avi Ornstein noted that, in addition, two RIGHTs can make a WRONG (in many ways).

A/S 3. Here's one from Jeff Kenton (and his mother?).

Suppose someone offers to play you a game with three specially made dice. He tells you that each die has from 1 to 6 spots on each of its 6 faces, but that the faces are not necessarily all different. The dice are "fair" in that each face has a 1/6 chance of being on top when its die rolled. If you agree to play (but not before) he will let you examine the dice and choose one. He will then choose a different one and pay you 6 dollars each time you roll a higher number than he does. If he rolls higher, you pay him 5 dollars. Should you ignore what your mother told you about betting against people with funny dice, and play the game?

The following solution is from Leonard Nissim:

The stranger can arrange the three dice to be non-transitive; that is, B will beat A, C will beat B, and A will beat C, even overcoming the payoff in your favor (win $6 when you win, lose only $5 when you lose).

Here is one such arrangement: Die A has (1, 4, 4, 4, 4, 4). Die B has (2, 2, 2, 5, 5, 5). Die C has (3, 3, 3, 3, 3, 6).

Note that if you choose A, then the stranger chooses B. He wins 21/36 of the time, while you win 15/36 of the time. Your expected payorr is (15/36) x (6) + (21/36) x (-5) = -5/12.

Note that if you choose B, then the stranger chooses C. He wins 21/36 of the time, while you win 15/36 of the time, for the same expected payoff of -5/12.

Note that if you choose C, then the stranger chooses A. Worse for you than the other cases, the stranger wins 25/36 of the time and you win only 11/36 of the time. The expected payoff to you is worse, -59/36.

With these dice, the best you can do is an expected payoff of -5/12. (Of the various solutions for the stranger with this value to you, -5/12, this one is pleasing in that no ties can happen when you play.)

It is amusing to note that the stranger need not use all the numbers from one to six to ensure that you have a negative expected payoff. Here is an example using only 1, 2, 3, 4, and 5; the best choice you can make gives you an expected payoff of -5/18: Die A has (1, 1, 3, 4, 4, 4). Die B has (2, 2, 2, 3, 5, 5). Die C need not even be rolled, as it has (3, 3, 3, 3, 3, 3).

Other Responders

Responses have also been received from M. Brennan, T. Bundy, F. Carbin, M. Cassidy, C. Dale, J. Drumheller, J. Dunham, R. Eiss, A. Fabens, S. Feldman, S. Goldstein, J. Grossman, R. Hansen, W. Hartford, R. Hess, A. Katzenstein, J. Keilin, L. Kells, P. Kramer, B. Layton, G. Perry, K. Rosato, J. Rosenthal, J. Rudy, J. Ryan, J. Salem, J. Shwimer, A. Tracht, and J. Walker.

Proposer's Solution to Speed Problem

It is not possible to drop a round manhole cover down a round manhole. □

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HOME: Rochester, New York

CAREER: Graduating from MIT in 1936 with a degree in management, Harry Essley worked several years before joining the Navy as an ensign in 1943. He married Elizabeth Gilman, a fellow naval officer, in 1945. They left the service the following year and moved to Rochester, her hometown, where Essley joined Eastman Kodak as a manufacturing engineer.

Since retiring in 1970, Harry and Elizabeth served a year in Jamaica on the hospital ship Hope; rafted the rapids of the Green and Colorado Rivers and hiked the length of Grand Gulch in Canyonlands, Utah; sailed the waters of the Finger Lakes, Thousand Islands, Cape Cod, Maine and Greece; explored the outback of Australia; rode the trans-Siberian Railroad across Russia; studied Mayan ruins in Yucatan; and swam with elephant seals in the Galapagos. Harry has been active in MIT affairs, serving as chairman of the Rochester Educational Council, on the Corporation Visiting Committee for Student Affairs, and on the Alumni Association Executive Committee. Now the Essleys enjoy visiting their four children and five grandchildren in Thailand, Alaska and Hawaii.

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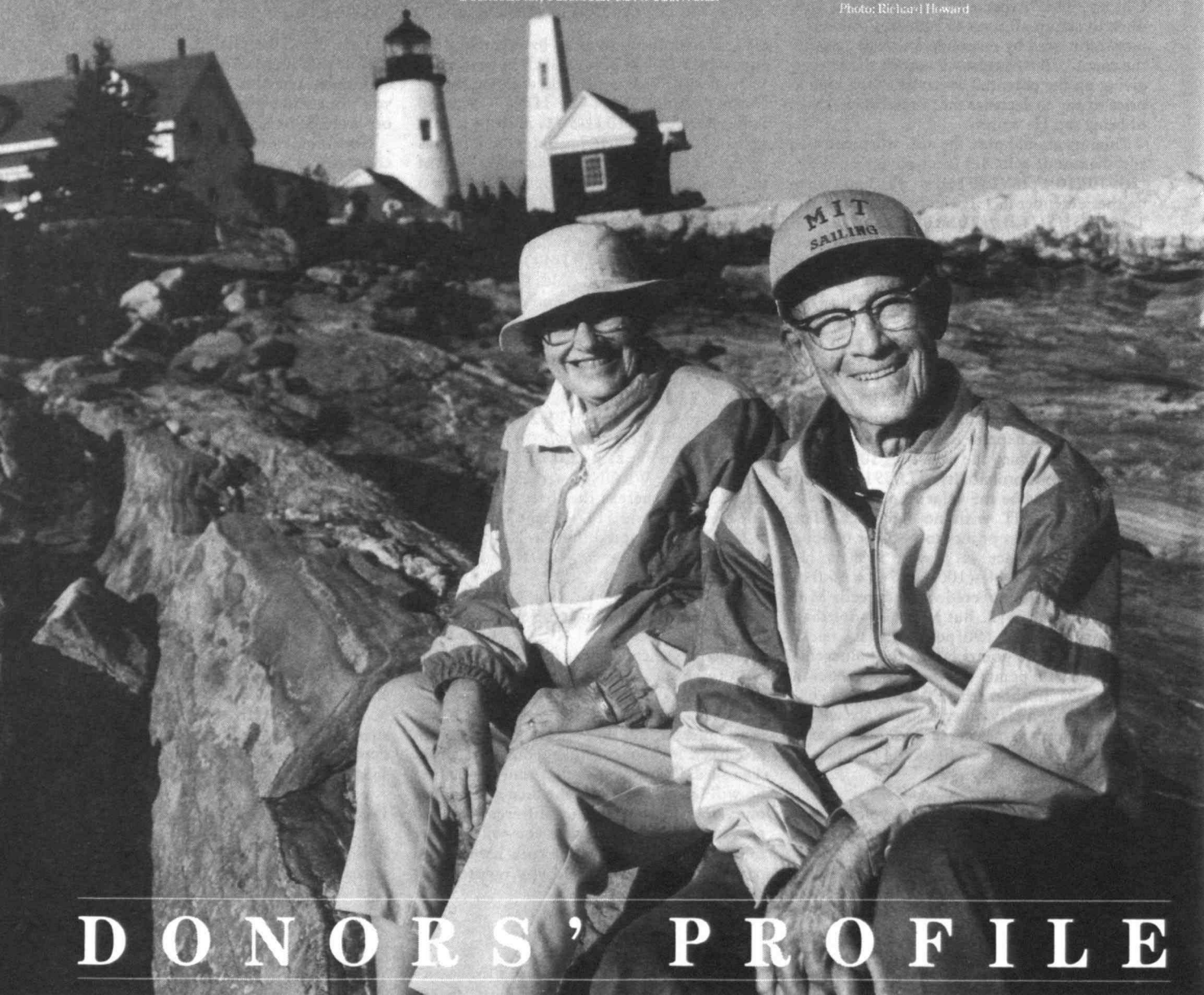
Photo: Richard Howard



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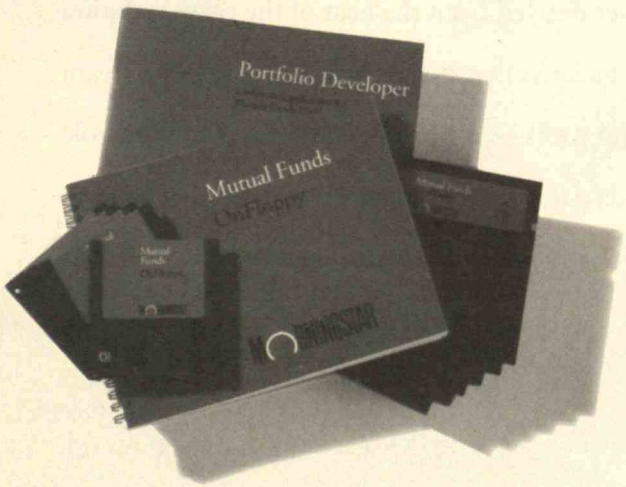

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MORNINGSTAR

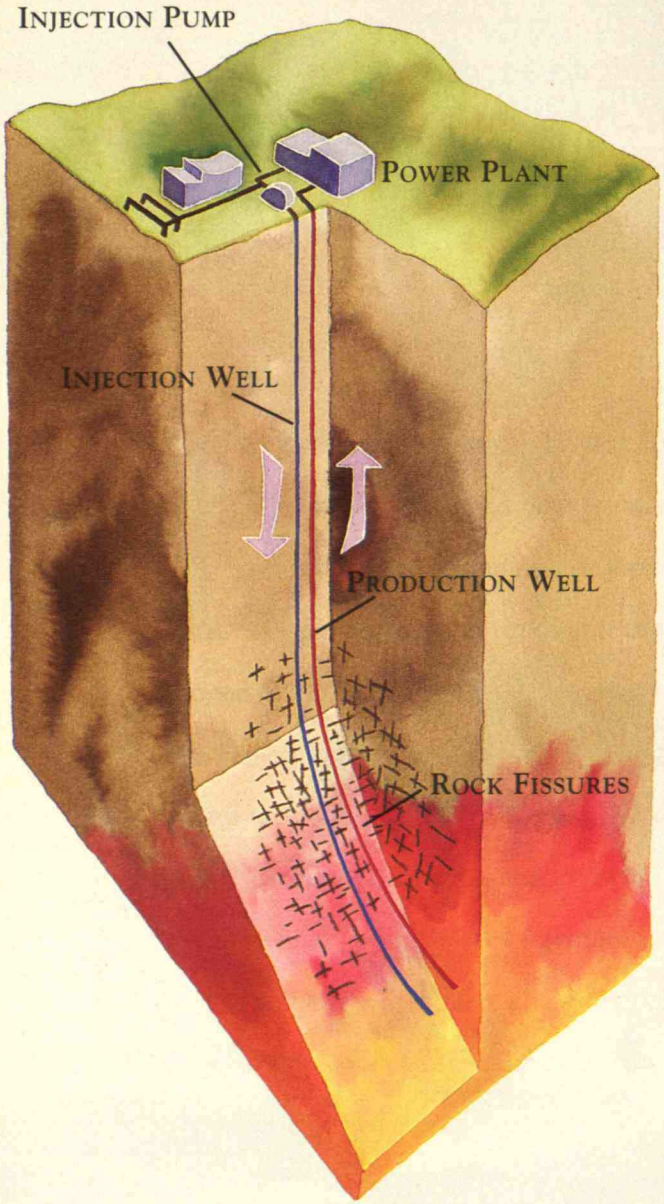
Tapping the Fire

BY DAVID TENENBAUM

Abundant reserves of heat lie beneath the earth's surface, and new technologies could improve our ability to use them as an energy source. But in the United States, at least, few people seem to care.

IN 1992 and '93, after a 20-year effort, a team from Los Alamos National Laboratory finally extracted heat from 453°F dry rocks that lay 12,000 feet below the nearby Jemez Mountains. For seven and a half months, the researchers pumped up to 100 gallons of water per minute through artificial cracks in those rocks, and the water returned to the surface at 350°F, carrying enough energy to produce a steady 4 megawatts of heat. Project leader David Duchane called it the "world's first practical demonstration" of the new technology, known as hot dry rock (HDR). While HDR could greatly boost the prospects of geothermal energy, or power derived from the heat of the earth, existing "hydrothermal" power plants—geothermal facilities that extract heat from water or steam that naturally circulates through underground rocks—are already playing a significant role in the energy economy. In California, Nevada, Utah, and Hawaii, 70 hydrothermal plants have an electric generating capacity of some 2,800 megawatts, almost enough for a million people (as calculated by dividing the total U.S. generating capacity by the population). All told, and little noticed, geothermal currently supplies the country with eight times as much electricity as two of the more popular forms of renewable energy—solar and wind—combined. What makes the ability to exploit hot dry rocks so exciting is that they are infinitely more common than natural reservoirs of hot water or steam. The more accessible HDR resources in the United States alone would provide an estimated 650,000 quadrillion BTUs,

Down Below



IN THE HOT-DRY-ROCK PROCESS, WATER IS PUMPED DOWN ONE WELL AND CIRCULATED THROUGH ARTIFICIAL FISSURES MADE DEEP WITHIN THE EARTH. THE WATER IS FORCED UP A SECOND WELL CARRYING THE HEAT NECESSARY TO GENERATE ELECTRICITY.

or quads of heat, one quad being the amount of energy contained in 171.5 million barrels of oil. Since annual U.S. energy consumption is 84 quads, whoever figures out how to economically tap even a fraction of the potential in hot dry rocks could earn a place in history.

Geothermal energy of any kind also boasts an impressive list of environmental advantages. The technology threatens no coastlines with oil spills. It requires no open pit mines. It produces no ash, no scrubber waste, and no radioactive waste. And although geothermal sometimes produces toxic waste from the dissolved or suspended chemicals naturally found deep in the earth, these materials tend to be more readily disposed of than those from other energy sources—virtually all U.S. generating plants simply reinject them into the reservoir.

When compared with other alternative energy sources, geothermal plants are reliable: the Department of Energy (DOE) reports that they have a 65 percent "capacity factor" (the ratio of actual output to the output that would result if the plant ran full-tilt, full time). New coal and new gas turbine plants have capacity factors between 60 and 70 percent; wind and solar thermal plants each come in at 21 percent. And geothermal relies on domestic labor, resources, and equipment—traits that would seem to make it irresistible in the United States, which imported half its 1993 oil consumption at a cost of $51 billion.

The difficulty is that creating a geothermal plant is expensive, largely because developers usually must bore holes a mile or so deep through hard rock. Even though geothermal plants need no fuel, making operating costs extremely low, the capital cost still works out to about $3,000 per kilowatt, says David Anderson, director of the Geothermal Resources Council, an industry educational group. By contrast, an efficient gas turbine plant costs just $824 per kilowatt. And although innovations such as new drilling technologies promise to cut expenses, geothermal still cannot compete with fossil-fuel-based electricity on price alone.

Unfortunately, geothermal—unlike other capital-intensive but environmentally sound energy sources—lacks the kind of support that could help surmount the obstacles to its use. Nevertheless, geothermal energy poses a question about priorities: can a nation worried about oil spills, strip mines, acid rain, greenhouse gases, and the balance of trade afford to take a laissez-faire attitude toward a domestic energy technology that produces essentially none of these problems?

DAVID TENENBAUM is a freelance writer who lives in Madison, Wis., and specializes in science, health, and the environment. His work has been published in American Health, Garbage, *and the* Los Angeles Times.

DIAGRAMS AND MAP: CYNDY PATRICK

MILGROW NURSERY HAS BUILT GREENHOUSES IN SOUTHWEST UTAH AND SAVED THOUSANDS OF DOLLARS EACH MONTH BY HEATING THEM WITH HOT WATER FROM A 600-FOOT-DEEP NATURAL RESERVOIR.

Manufactured Reservoirs

The best hydrothermal resources in the United States are found in California, where the Pacific plate is sliding beneath the North American plate, producing the kind of fault structure that allows water to circulate underground; California's Geysers field is the world giant in the industry, with a capacity of about 1,635 megawatts and a large market in nearby San Francisco. Other hot spots lie in the basin and range country of Nevada and Utah, where the earth's crust is thinning, and on the flank of Kilauea volcano in Hawaii. Plenty of hydrothermal energy remains to be exploited: a 1978 estimate by the U.S. Geological Survey found that it could supply 95 to 150 billion watts of electricity. (For comparison, a large nuclear reactor generates about .5 billion watts, enough for a city of 175,000.)

Geothermal can also provide heat directly and has in fact been used to heat buildings since Roman times. Geothermal heating districts—essentially public utilities that distribute hot water through a closed-circuit loop of pipe—were pioneered in Iceland, where they now warm about 80 percent of homes. The largest heating district in the United States, which began operating in San Bernardino, Calif., in 1985, distributes 132°F water through 17 miles of insulated pipe to 40 city and commercial buildings, serving a total of 2.25 million square feet. Because relatively cool fluid can be used for heating, the application could expand geothermal's reach in the United States to the cooler resources east of the Rockies. In the past few years, about 150,000 geothermal heat pumps, which concentrate earth heat for space heating, have been installed in the United States. Overall, such uses of geothermal annually save the country the equivalent of about 9 million barrels of oil.

Although heat pumps can be used nationwide, relatively few places on the planet have the underground resources for a hydrothermal power plant or a geothermal heating district. Fact is, this energy cannot be loaded onto a supertanker or hauled on a train. "The geothermal field is where you find it," observes Carel Otte, who directed Unocal Corp.'s geothermal division for almost 30 years. That's one reason researchers are so excited about the successful HDR test in New Mexico. Temperature increases with depth virtually everywhere on the planet, so a workable HDR technology could revolutionize the playing field for geothermal.

"This is something you could put in Madison, Wis., or New York City," says Jefferson Tester, director of MIT's Energy Lab. "You could sell the technology across the whole world." Indeed, Japan and five European nations have sponsored hot-dry-rock research programs. In the 1995 budget, DOE asked Congress for $4.1 million to subsidize a small commercial HDR plant, which Los Alamos project leader Duchane says could be producing electricity by 1997 or '98, either at the New Mexico site or elsewhere. And preliminary estimates of the cost of HDR electricity suggest that it might be relatively cheap, at least in areas where the earth gets at least 144°F warmer with each mile of depth and drilling costs are thus somewhat less formidable. Conditions like these are found under 40,000 square miles of the lower 48 states, Duchane says, primarily in Nevada, Oregon, and California.

However, HDR does require that workers create extensive underground fractures and pump water through them—in other words, it means manufacturing

PHOTO: DAVID TENENBAUM

ABOVE: EXTRACTING GEOTHERMAL ENERGY FOR UTAH'S BLUNDELL GENERATING STATION BEGINS AT THIS WELLHEAD SITUATED OVER A HOT-WATER RESERVOIR. RIGHT: THE FLUID FROM THE WELLHEAD PROCEEDS TO A STEAM SEPARATOR, WHICH SENDS STEAM TO A POWER PLANT AND WATER TO A SECOND WELL, WHERE IT IS REINJECTED INTO THE RESERVOIR.

a reservoir—and a few questions remain about the practicality of doing so. John Sass, a geophysicist with the U.S. Geological Survey, points out that the "flow test" performed at the New Mexico site—the test to determine if the reservoir could supply heat long enough to justify the cost of building a plant—would have been more conclusive if it had run for two or three years instead of less than eight months, at which point DOE closed the funding spigot. Sass also thinks the New Mexico reservoir is "pretty dinky" in size. Another "big hangup," he says, is the amount of pressure needed to force water through the rocks, which raises energy and equipment costs. "They are using 4,000 pounds per square inch and getting about 90 gallons per minute out. For a commercial system, you'd have to get ten times the amount of fluid through." On the other hand, Sass notes that such questions are no reason to give up on HDR. Besides being a worthy end in itself, the approach could enhance traditional hydrothermal, since techniques to create fracture zones could increase the water flow through existing reservoirs and boost energy output. "I like the idea of hot dry rock as the endpoint of a spectrum of activities that starts with hydrothermal," he says.

Many recent technical advances promise to benefit all varieties of geothermal. For example, almost any installation will require extensive drilling, and Supreme Resources Co. of Dallas is developing a drill bit that it claims has blasted through rock at more than 100 feet per hour in tests—a full order of magnitude faster than conventional drills. "Mud"—the fluid used to cool, lubricate, and remove chips—is forced through this bit at speeds of 2,000 to 3,000 miles per hour, so that it helps attack the rock. Since the new bit should seldom need sharpening, it could also minimize downtime, which is a key goal in any drilling system: drilling rigs can cost as much as $35,000 per day, whether they are actually drilling or simply raising a mile-long drill string to replace a dull bit. Robert Cox, a company executive, says the technology could cut drilling costs by roughly 40 percent. But it faces skepticism from its primary market, the oil industry, and after it broke repeatedly in early tests, the company was forced back to the laboratory; a new test is scheduled for December 1994.

Tester suggests scrapping the rotating bit entirely and attacking rock with heat. His proposal, called supersonic flame drilling, takes advantage of three physical properties of rock: it expands when heated, it conducts heat poorly, and it has low plasticity, so it tends to break rather than bend. The "drill" would burn fuel oil or propane with a 4,100°F flame. This would cause the rock it heats to expand quickly, but because of poor conductivity, the heat would not spread much, causing uneven expansion—great near the flame but practically nonexistent a short distance away. In a material with so little plasticity, this causes extremely rapid flaking.

Flame drilling's first advantage is that it's fast—it has already bored holes 2,000 feet deep at speeds of about 100 feet per hour. Also, since the drilling head does not touch the rock, wear should be drastically reduced. With neither bit nor rotating drill string, it should be more accurate and less likely to break down. According to Tester's calculations, supersonic flame drilling could slash the operating cost of drilling a foot in hard rock to $3, down from $100 to $300. Tester, who says the technology needs at least five years of R&D for com-

PHOTOS: DAVID TENENBAUM

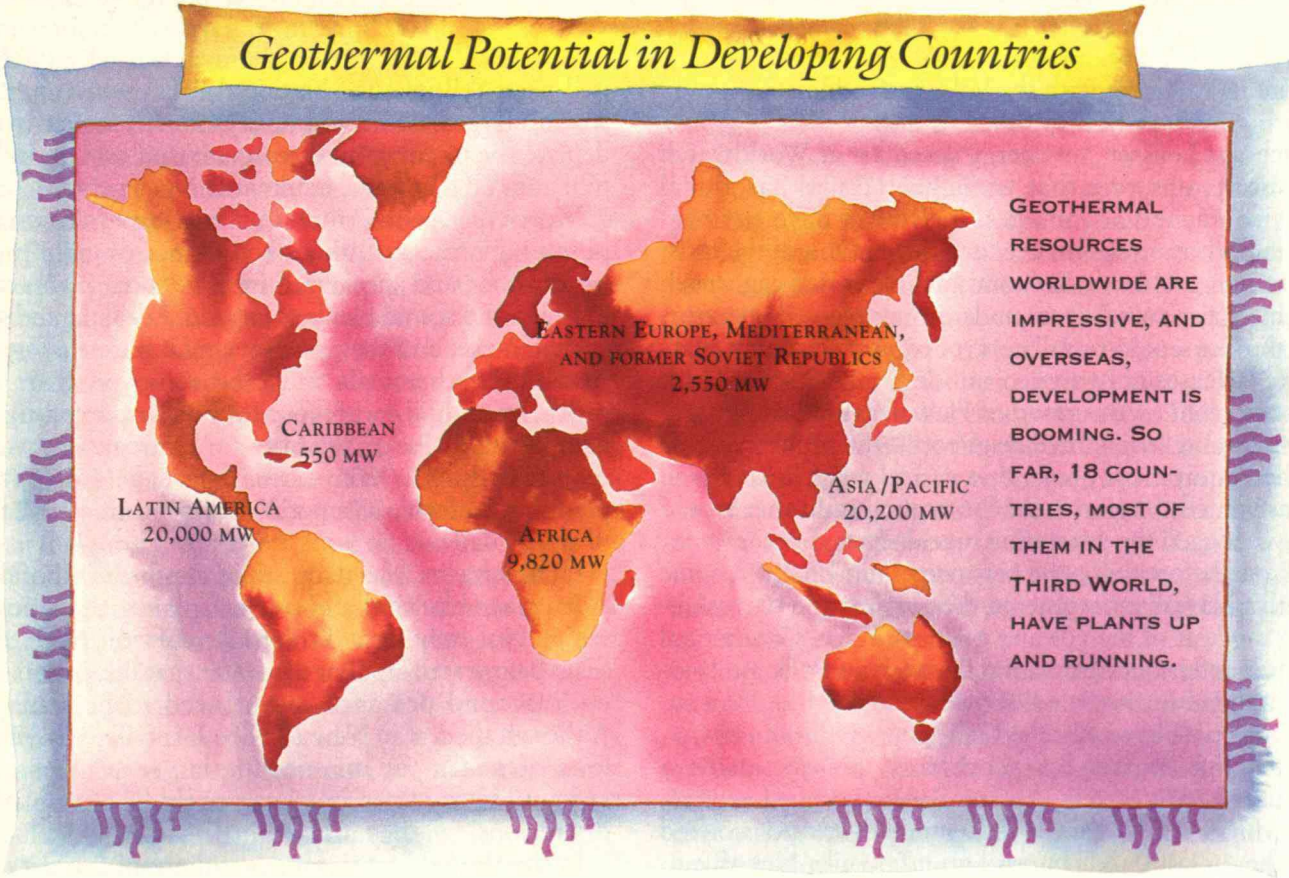
mercialization (to drill deeper holes in more types of rock), advocates a national program to investigate the application of flame drilling to tunneling and excavating as well as drilling.

Another major technical advance is a new type of generator called the "binary system," which allows electricity to be generated from lower-temperature resources. Unless they're tapping a steam-filled reservoir, conventional hydrothermal plants must deal with the problem of how to obtain high-pressure gas to drive their turbines, which becomes especially difficult when the geothermal fluid is not significantly hotter than the boiling point. Binary systems solve this problem by containing the geothermal fluid in a closed loop and transferring its heat to a working fluid, such as pentane, that boils at a lower temperature. Once this working fluid has driven the turbine, it is condensed and reused. A binary plant north of Reno, Nev., makes electricity economically from a 218°F geothermal fluid, a feat that would be impossible with a conventional generator.

Binary systems (and nearly all other generators) contain geothermal fluid in a closed loop, which helps prevent the reservoir-depletion problem that has plagued California's Geysers. In an underground version of the tragedy of the commons, steam from the field—which lay close to the surface and thus was cheap to tap—proved too enticing. So many generating stations were built that pressure began dropping by 50 percent in the late 1980s, forcing some plants to shut down and the others to scramble for replacement water to reinject to rejuvenate the field.

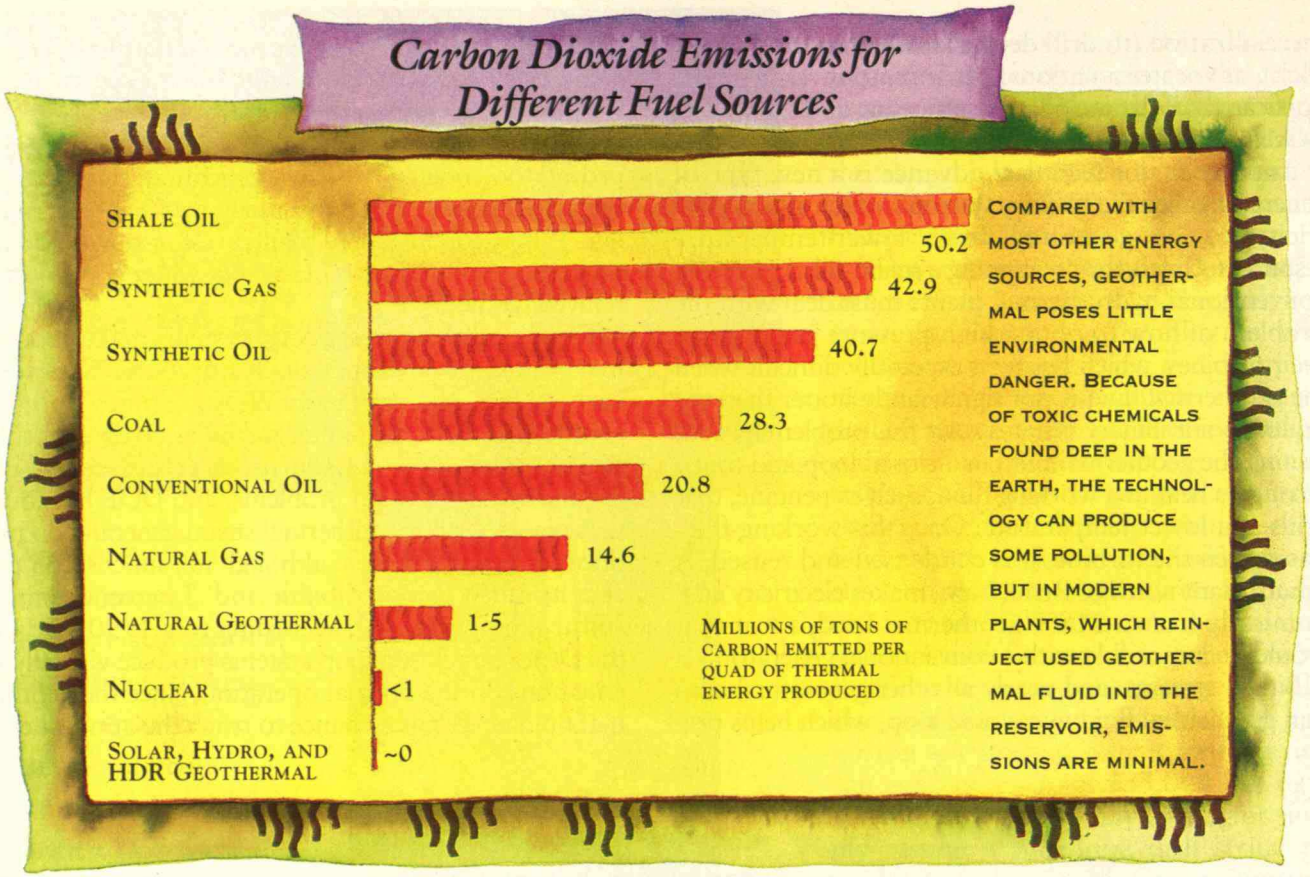
Finally, all these closed-loop systems make geothermal even more environmentally attractive. With some early plants, the contaminants sometimes found in geothermal fluid, including methane, hydrogen chloride, mercury, and radon, can cause air, surface water, or groundwater pollution problems, and DOE has found that plants venting geothermal steam generally do produce some air pollution, although not much—.05 percent as much carbon dioxide and .3 percent as much sulfur dioxide as coal, according to a 1990 study by the DOE. But closed-loop systems produce virtually no emissions during normal operation, since the geothermal fluid never has a chance to reach the atmosphere.

Geothermal Potential in Developing Countries



GEOTHERMAL RESOURCES WORLDWIDE ARE IMPRESSIVE, AND OVERSEAS, DEVELOPMENT IS BOOMING. SO FAR, 18 COUNTRIES, MOST OF THEM IN THE THIRD WORLD, HAVE PLANTS UP AND RUNNING.

DIAGRAM: CYNDY PATRICK



Coming to Terms with the Volcano Goddess

Nicholas Lenssen, an energy specialist at Worldwatch Institute, observes that while geothermal has global environmental advantages, it also can have environmental drawbacks on the local level. One of the most common problems, the unmistakable rotten-egg stench of hydrogen sulfide from underground, forced operators at the Geysers to install control equipment many years ago. Releases of hydrogen sulfide from a 25-megawatt binary plant on the island of Hawaii caused respiratory distress and hospitalized neighbors—the problems arose when equipment broke down, and when a new well was vented to remove the lubricating mud that would have clogged the generating machinery.

Long before that plant began operating in 1993, some native Hawaiians registered their opposition to exploiting the heat of the volcano goddess, Pelé. "Geothermal power is flat-out desecration," maintains Palikapu Dedman, head of the Pelé Defense Fund in Hilo, Hawaii. Similar problems dog the Philippine National Oil Co., which has pursued a geothermal project inside a national park on Mt. Apo on the island of Mindinao. The highest mountain in the country, Mt. Apo is sacred to the 460,000 indigenous Lamud people. Not all cultural opposition to geothermal concerns gods and goddesses: in 1993, geothermal development was prohibited near Yellowstone National Park, which has the world's largest collection of geysers, for fear it would deplete the underground reservoir and cast an industrial aura on a national landmark.

Moreover, geothermal facilities are heroic-scale plumbing projects with an abundance of giant pipes, huge valves, and specialized fittings. Some plants need mufflers and sound blankets to reduce drilling and generating noise, and they usually emit a plume of steam. And when chemicals must be removed from the geothermal fluid to prevent fouling or corroding the equipment, a sludge, possibly containing toxic waste, requires disposal. In an extreme case, a 34-megawatt plant in California's Imperial Valley produces 50 tons of sludge daily.

HDR systems would introduce another kind of difficulty, since like coal and nuclear plants, they require water. Not only would the rock reservoir have to be filled before start-up, but the water that disappears into underground passages would need to be replaced. Although the test in New Mexico lost only 7 to 12 gallons of water per minute, the larger water supply required by commercial plants could be a problem in dry regions.

In the United States, most geothermal capacity is a relic of regulatory and research policies developed in the late 1970s, when, shocked by the OPEC oil

DIAGRAM: CYNDY PATRICK

embargo, the federal government strove for a diversified energy supply. The geothermal budget peaked in 1979 at $150 million, immediately before the huge increase in geothermal capacity of the early 1980s. Then, soon after these plants came on line, the Reagan and Bush administrations slashed the budget—to a low of $18.5 million in 1990—and the number of new plants dropped in response. Today, more than two decades after the oil embargo, 85 percent of the national energy supply comes from fossil fuels, according to DOE's Energy Information Administration.

International interest in geothermal is much more intense. Ralph Boeker, CEO of San Diego's Magma Power Co., one of the biggest geothermal developers, predicts that overseas capacity, particularly in developing nations, will increase two- or three-fold within 10 years. At least three factors explain the rapid growth: geothermal's proven operating record, an unwillingness or inability to buy fossil fuels, and the advent of contracts that allow operators to repatriate profits. In a typical agreement, the developer builds and operates the plant long enough to earn a profit, and then sells it to the host country.

As a high-tech, capital-intensive industry, geothermal has been dominated by oil companies and other big businesses, turning off many environmentalists.

Eighteen nations now generate geothermal electricity, largely in the Ring of Fire surrounding the Pacific Ocean, where collisions of geological plates allow the earth's heat to rise near the surface. The Philippines, already the world's second biggest producer, is planning to triple its output of 900 megawatts by the year 2005. Magma has a contract to build a 231 megawatt plant (larger than any in the United States) on the Philippine island of Leyte. Geothermal is also surprisingly popular in fossil-fuel-rich Indonesia, which plans to expand its present capacity of 142 megawatts to 870 megawatts by the year 2000. The goal is to use geothermal energy to offset domestic consumption of fossil fuels and then export more oil and gas.

On the other side of the Ring of Fire, geothermal is gaining ground in Central and South America, where eight countries have a hydrothermal potential at least four times as large as their existing electric generating capacity. Mexico already has 700 megawatts of hydrothermal on line; El Salvador, 95 megawatts; Costa Rica, 55 megawatts; Nicaragua, 35 megawatts; and Guatemala, 2 megawatts. Dominica and St. Lucia, in the Caribbean, are planning installations.

Why is the picture so different in the United States? Because fossil fuels are so cheap right now. Environmentally minded geothermal advocates argue that fossil fuels only seem cheaper because some costs never show up on the utility's balance sheet or the customer's tab. The more measurable of these "energy externalities" include the health and environmental tolls of extracting, transporting, and burning fuels, and the military costs of defending fuel supplies. Other externalities, like the hazards of storing radioactive waste, the security costs and trade imbalances that result from massive fuel imports, and the long-term effects of depending on finite supplies of fossil fuel, are tougher to figure. Even more enigmatic is the cost of global warming owing to increases in greenhouse gases.

The difficulty hasn't stopped economists and environmentalists from trying to measure the externalities of fossil fuels, and some have come up with surprisingly large numbers. For example, in 1990, a study at Pace University concluded that the true cost of an unscrubbed coal plant was 11.6 cents per kilowatt hour (kwh), double the 5.8 cents that utilities were charging. And in 1991, Harold Hubbard, then a senior fellow at Resources for the Future, reported that the external costs of energy range from $100 billion to $300 billion per year in the United States.

Full-cost accounting could boost geothermal's stock considerably. In 1990, DOE predicted that a 2-cent-per-kwh surcharge on conventional electricity would allow renewables to compete for 40 percent of new generating capacity between 1990 and 2010. And although that kind of premium is about as likely as a glacier in Georgia, many externalities have started to show up in the energy equation. These include penalties for oil spills, the cost of restoring land after strip mining, payments to former coal and uranium miners for black lung disease and lung cancer, a tax on nuclear-generated electricity to fund radioactive waste disposal, and the expense of installing equipment to achieve the mandated 50 percent reduction in precursors to acid rain.

Most of the action is at the state level, where electric utilities are regulated. By 1991, 18 state public utility commissions were requiring utilities to account for external costs in their integrated resource plans. The Wisconsin Public Service Commission (PSC), considered a leader among utility regulators, uses several mechanisms to tilt the playing field toward renewables. PSC staff member David Iliff points to a $15-per-ton levy against generating resources that emit carbon diox-

ide. Wisconsin utilities are also allowed to add 3/4 cent per kwh profit for solar and wind electricity.

California's status as the world leader in geothermal and wind electricity is not solely attributable to its excellent geothermal and good wind resources, but also to decisions of its Public Utility Commission (PUC). During the 1980s, the PUC required utilities to buy a certain portion of their electricity from renewables. And although the impending expiration of some of those contracts is giving dyspepsia to developers of renewable power, the state has replaced this provision with a similar one.

The message is clear, Hubbard says. In different places, in different ways, "society has decided that externalities are real, and that they should be reflected in some way in the electricity picture. The argument is about the degree, and how it should be brought into the price." Lenssen agrees, and adds that "the trend toward tighter environmental standards all over the world will only encourage geothermal."

By 2010, geothermal power could supply the U.S. with the energy equivalent of 680 million barrels of oil.

An Energy No-Fan's Land

The real potential of geothermal is difficult to tease out of the arguments over price, supply, technology, and externalities. Over the short term, the Geothermal Resource Council predicts that the amount of U.S. electricity produced by geothermal energy will continue growing at today's 2.5 to 3 percent annual rate. Small installations are continuing to go on line in California, Nevada, and nearby states, despite the allure of burning cheap natural gas in highly efficient gas turbine plants. And over the longer term, the use of geothermal energy could increase substantially.

The wild card in the deck is unquestionably the prospect of global warming as a result of rising atmospheric concentrations of carbon dioxide and other greenhouse gases. "If we want to avoid carbon emissions, there are not many options that will be workable within a one-century time frame," says MIT's Tester. He notes that even if fusion ever works, it will be an expensive, high-tech solution not suitable to all societies. By contrast, geothermal, which can cost as little as 4.5 to 6.5 cents per kwh, is the cheapest source of renewable electricity, aside from hydroelectric power and wood-powered electric generators, which cost about 5 cents per kwh if the wood is cheap enough. The price of wind power has come down sharply in recent years, to an estimated 7.5 cents per kwh; solar thermal electricity is estimated at 8 cents. Photovoltaic solar, which costs 30 cents per kwh, is suitable only for remote installations.

Yet ask your average senator which renewable energy source has the largest potential and you are unlikely to hear geothermal. "The geothermal industry is really not playing an active role in coming to Congress, especially regarding our budget," says Allan Jelacik, geoscience team leader for DOE's geothermal division. Hot-dry-rock project head Duchane was one of many in the industry who could not name a single congressional supporter. Most discussions of the future energy picture—even those devoted to carbonless energy—give geothermal scant mention.

Geothermal's orphan status is clear in the 1995 DOE budget as well. The department's research requests for the year include $241 for nuclear energy, $300 million for solar and wind, $373 for fusion, $520 million for fossil fuels, $993 million for energy efficiency, and a mere $37.2 million for geothermal. Such comparisons leave advocates of geothermal feeling marginalized. "When you starve an idea," says Tester, "eventually the idea dies." Still, the picture is not entirely bleak. Secretary of Energy Helen O'Leary has indicated that geothermal's funding level may "need another look," and an increase, in future budgets.

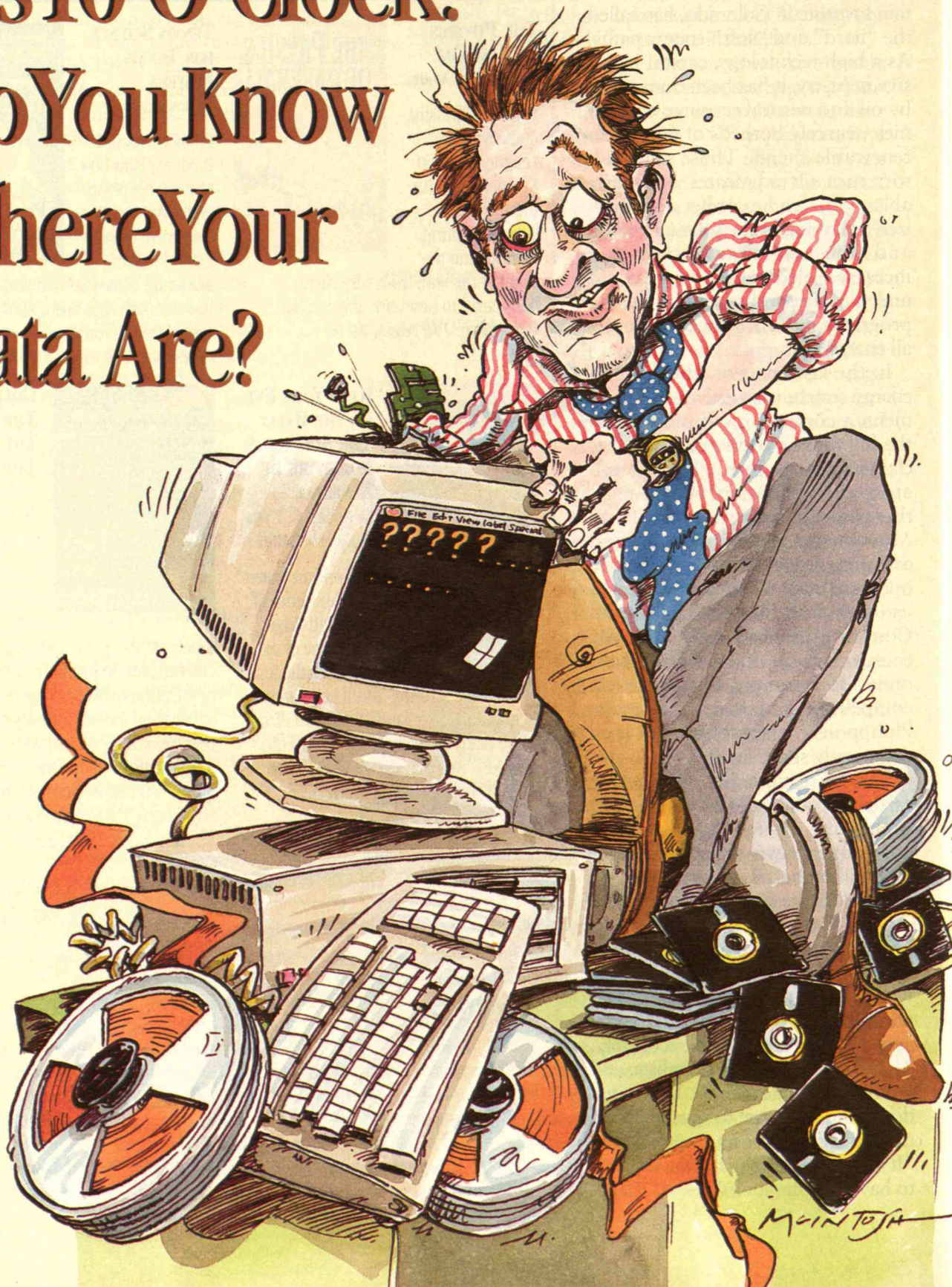
At present, geothermal electricity is only a regional phenomenon; it is generated in just a few western states. And unless HDR pans out, geothermal's overall potential is smaller than solar and wind, says Lenssen, who adds that capital-intensive geothermal seems risky to electric utilities still smarting from huge losses from nuclear plants. The lifetime of geothermal reservoirs and equipment can only be estimated, he notes. Tester suspects that an unfortunate feedback loop could explain the lukewarm interest in earth heat. "For the last 10 years," he says, "geothermal has been so underfunded that it has not been able to achieve the technical milestones that would build its political constituency." For example, funding was cut in the middle of the HDR flow test.

Geothermal's key political liability could be its position in a no-fan's land between what physicist Amory Lovins, director of the Rocky Mountain Institute in Colorado, has called the "hard" and "soft" energy paths. As a high-technology, capital-intensive industry, it has been dominated by oil and natural resource companies, scarcely hotbeds of interest in renewable energy. Those same factors turn off advocates of renewables, who tend to prefer decentralized technologies like solar and wind, and who sometimes worry that increased electricity supply could undercut demand-side management programs, which work to cut overall energy use.

In the last analysis, choosing an energy source is an exercise in judgment, a comparison of the costs of the full range of options. Nobody is claiming that geothermal is appropriate to every situation, but then neither is a strip mine or a wind farm. Most energy experts now suggest avoiding overreliance on any one option in favor of a mix of strategies, using each in its best application. Conservation can help increase energy services in wasteful economies, for example, but it's far less compelling in countries like the Philippines, where electricity is in desperately short supply.

The DOE says that promoting earth heat could allow the option to supply the United States with 4 quads of energy—the equivalent of 680 million barrels of oil—by 2010. But unless we begin making some serious changes in the energy economy, this country could wind up in 30 years exactly where it was headed when the first energy crisis stormed out of the Middle East 22 years ago—with a fossil-fuel economy. That disturbs environmentalists, and advocates of geothermal. "It just doesn't make sense to give geothermal so little attention," says Tester. "It would be healthy for the country to have another look."■

It's 10 O'Clock: Do You Know Where Your Data Are?



BY TERRY COOK

ONTARIO Hydro's nuclear power plant near Toronto was losing its memory. The condition—a breakdown of its electronic record-keeping faculties—first appeared when the utility could find no record of a crucial reactor sealing ring that had suddenly begun wearing out several years earlier than expected. To obtain some replacement rings fast, the plant's managers and scientists had to know immediately who sold them the parts, when they had been ordered, and whether the contractor provided guarantees against defects.

The records manager of the huge provincial utility blamed the lost records on the recently installed computer network and worker unfamiliarity with the company's new practices for storing documents. But as she and the staff searched frantically for the stray document, she discovered that the problem was now a chronic one. Despite management directives that all employees print out paper versions of electronic documents and place them on file, the volume of paper records arriving at the central storage office had dropped by 50 percent within six months of the network's installation. The actual work was still being done, but workers were now deciding that they were their own best records managers and archivists.

In the company's former paper-only system, information about a defective part could easily have been found by retrieving a carbon copy of the purchase order, which a secretary would have typed and given to a clerk for filing in the records office. But in the electronic world Ontario Hydro had adopted, few secretaries and records clerks remained. The only "filed" copy of a purchase order, if it existed, would reside on an individual's hard disk drive, but then only if the employee remembered to save it in the first place, and if he or she had not deleted the years-old document while freeing up disk space. More-

Computers can generate megabytes of data at near light speeds but can delete essential records just as quickly. Archivists are working to adapt traditional methods for managing paper, and devise new ones, for the brave new world of electronic virtual documents.

ILLUSTRATIONS BY JON McINTOSH

over, given that employees were allowed to name files according to personal whimsy, and that files were password-protected, access to the electronic version of the purchase order would be possible only if the employee had not left the company and was available when needed.

Ontario Hydro is not alone. Reports of lost or scrambled electronic data are coming in from a variety of sources, including major governmental organizations. For example, the United Nations recently discovered that methods for identifying, storing, and retrieving vital electronic data, such as field reports on social and economic issues in developing countries, had been completely ignored since the widespread introduction of office-automation technology. Similarly, the National Archives of Canada recently investigated the electronic files of one of the country's cabinet ministers and found not only that 30 of 100 randomly chosen policy documents could not be found in the government's paper records, but also that no system was in place to safeguard the contents of the electronic system. The National Archives and Records Administration in Washington, D.C., a repository for all government records, reports that older magnetic tapes containing data received from various government departments were suddenly unreadable after just 15 years. Because the temperature and humidity of storage areas in several departments were uncontrolled and the tapes were not rewound regularly or copied every few years, as recommended by archival conservation standards, the tapes became so brittle that they melted or caught fire when run on new drives that spun the tape some 10 times faster than earlier models.

Perhaps the most spectacular example of a government agency losing its electronic memory recently occurred at the National Aeronautics and Space Administration when space scientists were eager to access some 1.2 million magnetic tapes of observations that NASA created during three decades of space flight. The researchers were hoping to reveal "long-term trends like global climate change, tropical deforestation, and the thinning of the atmospheric ozone layer," according to NASA, as well as new nuggets of information about the moon and planets. But the information could not be read or sometimes even found. Tapes were uncataloged. Some had been damaged by heat or floods. Many were unlabeled as to which mission or spacecraft or computer system created them. Because no proper archival controls for these records were in place, NASA officials estimate that it will take millions of dollars and years of detective work to link each of the files to their spacecraft or mission and then decode the information so that it can be read by hardware and software now in use.

Underlying each case of lost data is a fundamental change in the way institutions now store information. For the first time in 3,500 years of archival activity we produce records that do not exist to the human eye—unlike Babylonian clay tablets, Egyptian papyrus, Roman and medieval parchment, modern paper, even microfilm. For the first time, business and professional people with no training and usually no aptitude for managing records are responsible for creating and storing them. Perhaps most significant, for the first time, we are not producing, managing, and saving physical artifacts, but rather trying to understand and preserve virtual patterns that give the electronic information its content, structure, context, and thus its meaning. Yet these patterns are completely controlled by software, which over the years will be modified, updated, and replaced countless times. Unless organizations adopt a means to control key records and continually migrate them to current software and new storage media, the long-term memory of our modern institutions will be in jeopardy, as will their ethical, legal, and economic health.

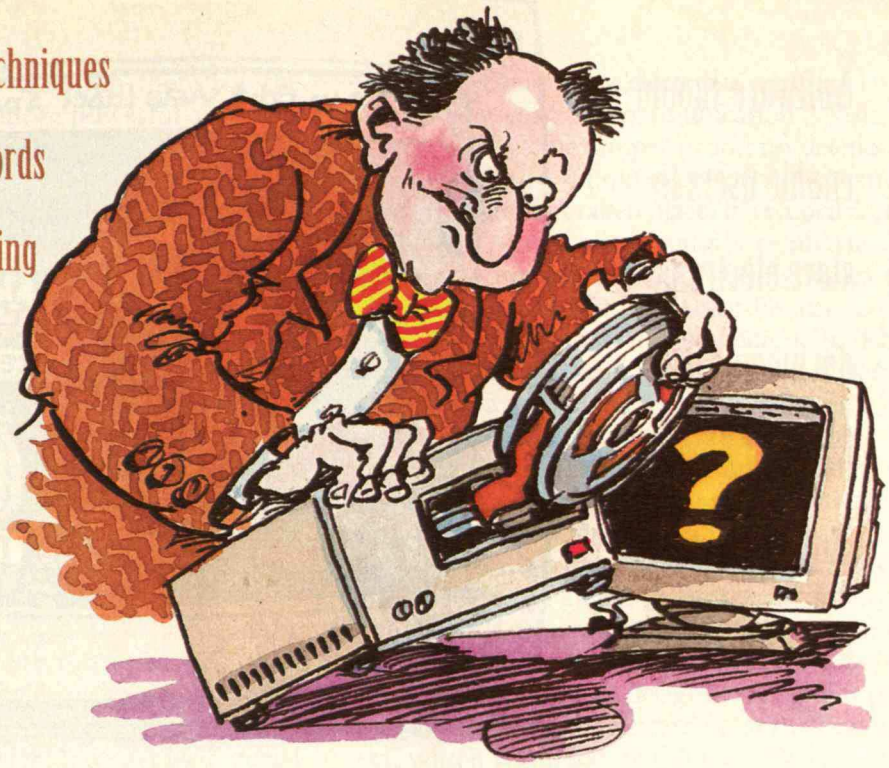
Unchained Memories

Disaster can occur not only because electronic information is hard to preserve but also because it is hard to control. Imagine that a chief executive officer sends a crucial policy-related e-mail message to her corporate administrators on November 23, 1994, and attaches a report containing graphs generated from spreadsheets linked to a database whose values change daily. The message and attachments detail investment strategies for the company and key clients.

Imagine also that one of the managers is later fired for failing to carry out the CEO's directives, thus having cost the company several important clients, and that he sues the company for wrongful dismissal, claiming he never received the CEO's e-mail message. If that same message had been sent in 1984 or 1974, or even 1904, it would have been a typed paper memorandum, addressed to the group, copied to others, and signed by the CEO, with a hand-drawn chart in the body of the text and figures and statistical tables in an appendix that would be physically stapled or paper-clipped to the CEO's memo. Any legal dispute could thus be settled by recourse to the paper file where the whole package sent by the CEO would reside, with evidence of signatures, routing-slip initials, or acknowledgment-of-receipt stamps.

TERRY COOK is the director of the Records Disposition Division at the National Archives of Canada. A former editor of three national journals on archives and history, he has written and lectured widely on archival issues.

Organizations need techniques for controlling key records and continually migrating them to contemporary software and storage media.



Not so with the electronic version. Even if the computer system's backup tapes survive, which is no guarantee in many workplaces, could the corporation retrieve and, more important, reconstruct the CEO's compound electronic document two years, or maybe even ten years, after the fact? Could it prove that the offending administrator had actually been on the original e-mail distribution list and had been sent the document? Could it prove that he had received the document and either filed or deleted it? Could it recreate the attachment as it actually existed on November 23, 1994, from the ever-changing spreadsheet tables? Could it prove that no subsequent alteration or unauthorized access to the data or system had occurred?

The key to maintaining critical electronic information lies in being able to determine, sometimes long after the fact, not only the content but also the context of a record in question. Such a contextual view of information is the purview of archivists, who, unlike librarians, want to know not just what was communicated but when, by whom, to whom, where, how, why, using what media, and connected to what broader programs and activities, both now and over time. Using skills honed in managing the voluminous paper records of the modern state, archivists are now obviously obliged to develop similar approaches to stop the memory loss of the electronic age.

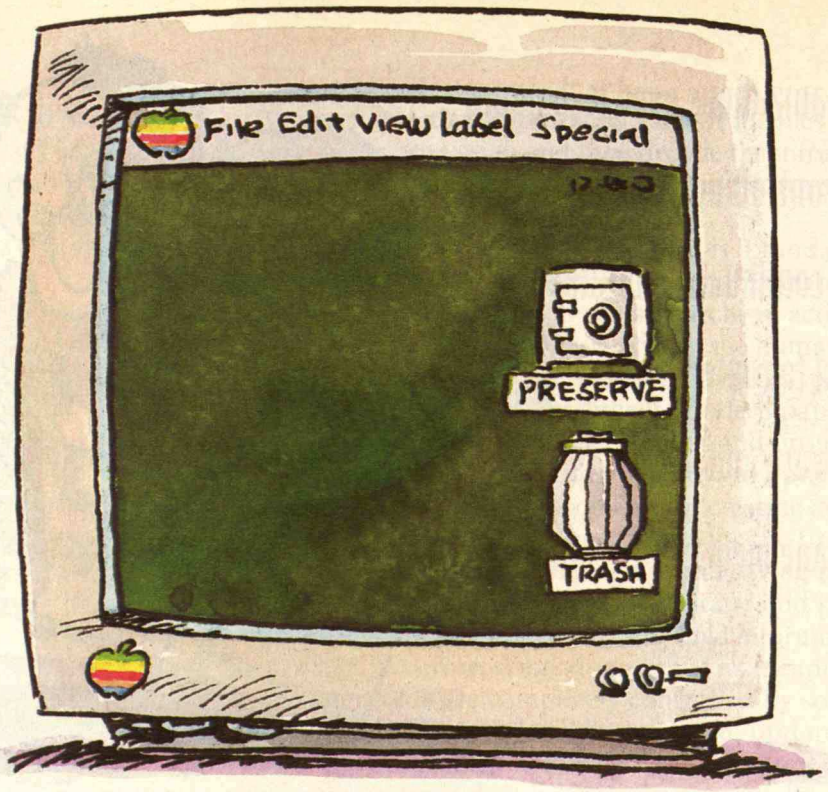
At the center of all archival thinking is the "record." Whether a parchment court roll, a frontier-land patent, a business report on a paper file, or an electronic message, all records have three properties: content, structure, and context.

For paper records, all three elements are represented on the same physical medium. Content is most obvious: it is the words, phrases, numbers, and symbols composing the actual text. The structure of paper documents is also readily evident from the form used for special kinds of transactions: a business tax return is different from a land-grant certificate. The context for paper records is derived from the signature lines, the signature itself, the address and salutation, the letterhead, the date, the carbon copies or "cc" line on the bottom of the page, perhaps the surviving envelope, various stamp impressions or annotations of date of receipt or filing, the position of the document within a larger paper file of related documents, the file heading or title, the file's own place within a larger records classification system, charge-out cards recording who has read the file on what date, and cross references to related documents in other media, including photographs, maps, and so forth.

Archivists consider this contextual information essential to the comprehension of any "record" as a reflection of acts and transactions, and thus of institutional accountability. Without context, one is left with information but not a record, and no memory on which to base future decisions or defend earlier ones.

For electronic media, the content, structure, and context of the record change significantly from that of the traditional paper world. The only approximate match with paper is the content element, where the letters and numbers look much the same on the computer screen as on paper. But the structure and especially the context of electronic records are not appar-

Software should enable users to store electronic documents in a way that preserves both their content and their context.



ent when retrieved from the text only.

Think of the CEO who sent out her message on investment strategies electronically. The interconnections of her compound document are not part of what the user sees on the screen, as they would be in a paper world, but rather are links in software or in the operating system. These instruct the computer to query the database, drop the relevant values found there into the spreadsheet, build a graph using spreadsheet formulas, and place the resulting graph in the appropriate spot in the word-processed report that is attached to the e-mail.

No such product is actually stored anywhere in the computer. Rather, at a particular moment in time, the software and operating system must stitch together information that is scattered in many places to form that virtual document. Upgrade or change that software and system, alter any of the data values, and those relationships among the e-mail, report, graphic, spreadsheet, and database are lost, as they are in the vast majority of systems operating in businesses and governments today. The virtual document vanishes. Corporate memory is wiped clean.

Preserving Electronic Records

What can be done to stop the erosion of institutional memory in an electronic world? How do we protect the content, structure, and context of electronic records over time? Before addressing what will work, it may be useful to look at three options that have been proposed or tried, each of which has serious flaws.

The first option proposed and rejected by numerous corporations and government agencies is to impose a single hardware and software standard on all records creators—everyone within the organization must use WordPerfect 6.0 with Windows, for example. Such policy fiats would be virtually impossible to implement and enforce outside rigidly hierarchical organizations like the military and the police. Nor are they desirable, for they undermine end-user creativity, lead to unhealthy monopoly situations for the makers of the hardware or software of choice, and curtail levels of comfort with preferred technology. A related approach would be to preserve only generic data, such as ASCII text, which is not hardware or software dependent and thus could be read using "off-the-shelf" standard software. This in fact was the archival preservation option used in the 1970s and 1980. But it is no longer feasible for today's software-dependent records, which are to complex to translate into ASCII format.

A second option proposed by several entrepreneurs in the past few years is to create a cybernetic museum with working models of every known piece of obsolete computer hardware and software, so that institutions and archives may gain access to old files and convert them to whatever may be the present-day standard. Unfortunately, the likelihood of keeping any piece of machinery running for many decades is simply not very high, since replacement parts, chips, and software could not be easily reproduced. A computer system is far more complex than a steam locomotive or shuttle loom.

A third option increasingly favored by information technology professionals is to dump all electronic information in no particular order on CD-ROMs or high-

density diskettes, and then to search them for the required subjects using ever more powerful artificial-intelligence text-retrieval programs. But while related material can be retrieved in this approach, so would be a great mass of extraneous information containing the same search strings.

For example, one researcher at the National Archives of Canada recently used such a strategy to try to find information from the defunct Trade Negotiations Office concerning plans to expand sales of Canadian freshwater to the United States. He searched the agency's electronic files for references containing the word "water." Even though the trade office was in operation for only a couple of years and employed only a few people, the researcher found more than 600 items containing the word "water." Yet while some related to the subject, many did not, especially since archivists, faced with a save-all or delete-all situation, chose to preserve all the backup tapes of the system. Thus the researcher found many items like "Meet me at the water cooler," and "My report was sure watered down by the boss."

Moreover, references that might have detailed crucial policy decisions but did not contain the word "water" were missed entirely: "About that matter we discussed this morning, the Prime Minister instructs me to tell you that under no circumstances shall we bargain it away unless the United States makes major concessions in agricultural products." Free-text searching, while better than nothing, does not uncover all the relevant records related to a particular function, activity, or transaction, nor does it preserve the context of or reason why a record was created.

A fourth option, now being explored by a team of archivists led by Richard Cox and David Bearman in a project at the University of Pittsburgh, and by John McDonald at the National Archives of Canada, is to determine the functional requirements of defining and safeguarding a record in a world of virtual rather than physical documents. The Pittsburgh project team has thus far determined the following set of needs for capturing, maintaining, and using electronic records:

- Records must be comprehensive: a record reflecting who, what, when, where, why, with whom, and so on, must be created for every business transaction. Courts accept records as evidence when they are produced under identifiable controls and standards. Thus records cannot be created for some transactions and not for others, or else the trustworthiness of the institution's record-keeping system would be thrown into doubt and its value as evidence considerably weakened.
- Records must be authentic: authorizations for access to the data, or parts of it, must be recorded, and traceable to each record and transaction. Verifying what was sent, seen, received, and deleted by whom requires capturing the kind of security controls that exist in the paper documents in the electronic records as well, or the overall context of the communication is lost.
- Records must be tamper-proof: no deletion or alteration to a record should occur once the transaction to which it relates has taken place. If a record is changed or corrected, a second record must be created and linked to the first. Moreover, each use, viewing, indexing, classifying, filing, or copying of a record is also a transaction and thus must generate its own record. To determine in a lawsuit whether the parties to a business decision were negligent, lawyers have to know on which computer records the responsible officers based their decisions. That is impossible unless the indexing and searching patterns used by the system are captured for the time each decision was made.

The Pittsburgh team believes that each organization should assign to a chief information officer or other senior staff formal responsibility for implementing these and other guidelines for generating and protecting records in new system designs and system reengineering plans. In fact, the next steps of the Pittsburgh project, which is funded by the U.S. National Historical Publications and Records Commission and scheduled to be completed in 1995, will help information officers meet these goals.

The team plans to translate the guidelines into technical specifications that programmers can use to instruct computers to automatically create appropriate records. In the terminology of the field, programmers would be creating metadata, which are additional data that encapsulate or surround the original data and tell them how to act, place them in the context of the business transactions to which they relate, and maintain their integrity and authenticity.

Software companies would design these record-keeping capabilities into their new products, especially integrated business applications such as word processing, spreadsheet, graphics, and database programs. End users will create the markets for such new software products either by recognizing their intrinsic value for safeguarding corporate memory or by responding to the growing number of data disasters and lost records.

As society shifted a millennium ago from the oral to the written record, the focus of archivists changed from remembering an action to caring for the written artifacts that gave evidence of the action. As society now moves from written records to virtual documents, archivists are offering their traditional understanding of the structure and context of recorded evidence as protection against the widespread amnesia now threatening our electronic world. ■

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The Chlorine Controversy

BY GORDON GRAFF

CHEMICALS containing chlorine—*all* chemicals containing chlorine—have become increasingly suspect. Amid evidence that some chlorinated pesticides, solvents, plastics, and even byproducts of elemental chlorine from its use in water purification are harming wildlife and perhaps people, environmentalists and legislators are calling for sharp cutbacks in the production, use, and discharge of chlorinated products.

Critics include not only the environmental activist group Greenpeace, which has launched a high-profile campaign to totally eliminate chlorine compounds, but others calling for less extreme though still serious measures. In August 1993 Rep. Bill Richardson (D-N.M.) proposed a bill that would require pulp and paper manufacturers to phase out the use of chlorine in bleaching operations. Such bleaching is known to produce traces of dioxins and other potent compounds that can induce cancer. The International Joint Commission (IJC), an environmental-policy group organized by the U.S. and Canadian governments that focuses on the Great Lakes region, has recommended banning chlorine and chlorine-containing compounds as industrial feedstocks. Several European organizations—the Oslo and Paris Commissions for the Prevention of Marine Pollution, the International Whaling Commission, the World Wilderness Conference, and the Barcelona Convention on the Mediterranean Sea—have echoed the IJC recommendations. And most recently, in March 1994, the American Public Health Association, a professional society, called on industry to reduce or eliminate chlorinated organic compounds in its products and processes and to introduce "lower-risk" substitutes.

Some environmentalists are calling for the total elimination of the many chemicals containing chlorine. While that will not likely happen, government and industry could take measures to reduce the use of unsafe compounds.

The list of charges against chlorine is lengthy. According to critics, chlorine

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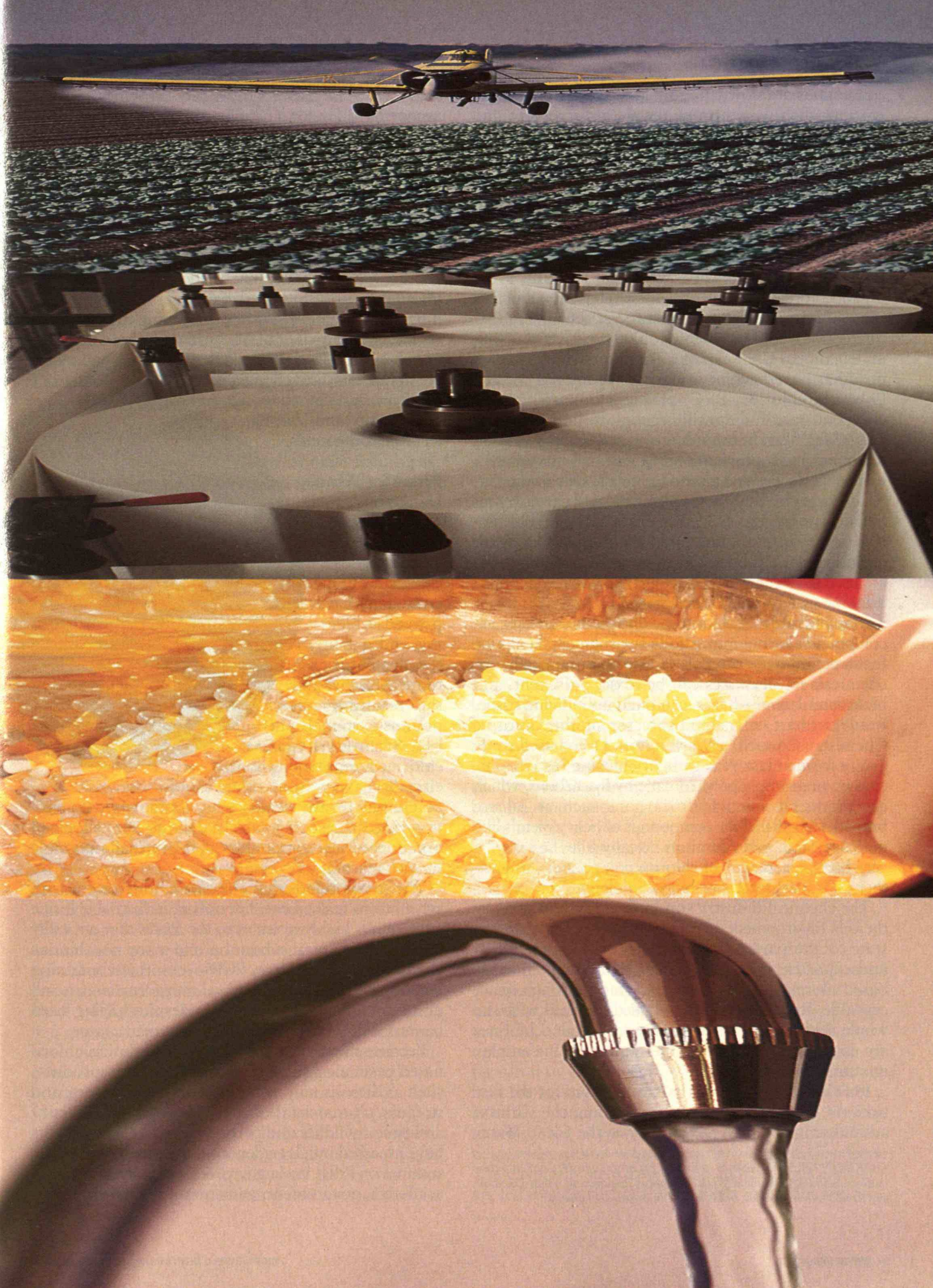

compounds are slowly poisoning the earth, insidiously working their way through the air, groundwater, and food chains, contributing to ozone depletion, destroying wildlife, and causing cancer and infertility in humans as well as a host of other ills. "Overwhelming" numbers of organic compounds containing chlorine—organochlorines—"tend to be toxic and persistent in the environment," says Joe Thornton, Greenpeace's research coordinator. "This doesn't mean that all chlorine compounds behave the same way, but virtually every organochlorine that's ever been tested has been found to cause at least one significant adverse effect."

Chlorine is used in roughly 15,000 products with estimated annual U.S. sales of $71 billion. Many of these products have become integral to industrial society. Polyvinyl chloride (PVC) plastics, for instance, are cheap, strong, and durable enough to find service in everything from house siding and sewer pipes to food wrapping and toothbrushes. The vast majority of commercial pesticides and pharmaceuticals, such as the herbicide atrazine, vitamin supplements, and cardiovascular and central-nervous-system drugs, also contain chlorine or are manufactured using chlorine-based chemistry. And chlorine and chlorine-based compounds are used to disinfect 98 percent of the publicly supplied drinking water in the United States.

Manufacturers of chlorinated chemicals say that such compounds are not intrinsically environmental culprits. Instead, industry representatives maintain, various chemicals in all classes can be toxic, persistent, and bioaccumulative—that is, can build up in living tissue. Brad Lienhart, managing director of the Chlorine Chemistry Council, a Washington, D.C.-based trade group formed last year to fight chlorine restrictions, cites as an example polyaromatic hydrocarbons, which are produced when hydrocarbons such as oil are burned. Others include compounds of heavy metals like mercury, lead, and cadmium. Meanwhile, he says, "a very high percentage" of chlorine compounds "are neither toxic, persistent, nor bioaccumulative."

The chemical industry supports the system used by the U.S. Environmental Protection Agency (EPA) and its state counterparts today, in which risks are identified and exposure guidelines set for individual chlorine-based chemicals. But critics find this approach unacceptable. Regulatory agencies need "to deal with the whole field of chlorine" at once since "organochlorines are not formed one by one; they're formed in complex mixtures," says Thornton.

In February of this year EPA weighed in for the first time on the subject. While announcing the Clinton administration's plan to reauthorize the Clean Water Act, EPA administrator Carol M. Browner said the agency "will develop a national strategy for substituting, reducing, or prohibiting the use of chlorine and chlorinated compounds." The statement, which actually amounted to a proposal to study the feasibility of reducing some uses of chlorine, satisfied neither side. It predictably rankled an industry concerned that this was the first step toward a chlorine ban, and it dismayed environmentalists who felt that it didn't go far enough.

But it wasn't an unreasonable idea for an agency seeking middle ground in a debate over how to protect humans and wildlife without imposing unacceptable economic and quality-of-life burdens. A growing body of scientific evidence suggests that both EPA and industry should consider taking a variety of measures to reduce the production and use of chlorine compounds.

Persistent When Dangerous

At the root of the controversy over chlorine are properties that have proved a blessing and a bane: the element is extremely reactive and the resulting compounds extremely stable. Strongly negative chlorine atoms tend to snatch electrons away from other atoms, accounting for the element's high reactivity with electron-rich carbon compounds and the diverse panoply of organochlorine compounds that are made possible by such reactions.

The strong bonds that chlorine tends to form with other atoms make some, but not all, industrial chlorine compounds highly resistant to the forces that normally break down natural substances and many nonchlorine chemicals. For example, PCBs—chlorine-containing insulating fluids used in electrical transformers—are still ubiquitous in the environment despite having been banned in 1976 because of links to human cancer.

Because they break down extremely slowly, chlorinated pesticides, solvents, and industrial byproducts such as dioxins may accumulate in lakes, rivers, and streams, ultimately affecting health and reproductive abilities of wildlife and perhaps humans. Researchers have amassed much evidence of specific effects. In the summer of 1991, leading environmental scientists from academia, government, and environmental organiza-

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PHOTO: GARRY D. McMICHAEL/PHOTO RESEARCHERS INC.

tions met to compare notes about their studies of chemical effects on wildlife. They concluded that some organochlorines—including the herbicide atrazine, the insecticide oxychlordane, and the industrial chemical pentachlorophenol—as well as certain nonchlorinated compounds such as the pesticides amitrole, carbaryl, and parathion could disrupt the endocrine systems of both wildlife and humans. That system controls many aspects of development and behavior through the production and release of hormones.

The researchers linked this effect to a host of recently observed ills in fish, birds, and mammals, including thyroid dysfunction, decreased fertility, gross birth deformities, and metabolic and behavioral abnormalities. The scientists also drew an association between these chemicals and sexual abnormalities: masculinization of female fish and birds and feminization of male fish, birds, and mammals. The researchers further connected organochlorines to damage to the immune systems of birds and mammals, leaving them prey to infectious diseases.

Some 15,000 products, including many pesticides, pharmaceuticals, and plastics, either contain chlorine or are manufactured using chlorine-based chemistry.

Even more worrisome are recent reports of connections between endocrine-disrupting organochlorines and human problems. Scientists including reproductive physiologists Richard M. Sharpe of the British Medical Research Council's Center for Reproductive Biology and Niels Skakkebaek of Denmark's National University Hospital have blamed organochlorines for various reproductive-tract cancers as well as low sperm counts and, more generally, male infertility, both of which seem to be on the rise in industrial societies. In 1993 Mary S. Wolff, an associate professor of environmental and occupational medicine at the Mt. Sinai School of Medicine in New York, showed a positive correlation between breast cancer and blood-serum levels of DDE, a chemical breakdown product of DDT, in a group of 58 women. Wolff and other researchers have cited the ability of certain chlorinated compounds to mimic the action of estrogens, female sex hormones, as a possible cause of this effect. And Joseph Jacobson and Sandra Jacobson, psychologists at Wayne State University in Ohio, claim that pregnant women who eat fish exposed to high levels of PCBs have given birth to abnormally small babies who later exhibit behavior problems and intellectual deficits when they reach school age.

But the case for adverse human health effects from environmental organochlorines is not closed. A study published in 1994 by epidemiologist Nancy Krieger of the Kaiser Foundation Research Institute in Oakland, Calif., found no statistical link between the incidence of breast cancer and DDE or PCB concentrations in a group of 150 women. And a paper published last July in the *British Medical Journal* called into question the reliability of sperm-count data that Sharpe and Skakkebaek depended on.

These inconsistencies and uncertainties do not surprise researchers who doubt that organochlorines that are estrogen mimics are present in the environment in quantities large enough to have any effect on human health. "The average human exposure to estrogens is 99.999 percent from natural sources," says toxicologist Stephen Safe of Texas A & M University. Still, most scientists find the evidence of adverse human health effects from cholorinated organic chemicals alarming enough to warrant further exploration.

As long ago as 1972, the U.S. government first banned a chlorinated compound, the pesticide DDT, based on overwhelming evidence about reproductive failure in birds and other wildlife. Through the remainder of the 1970s the government, suspecting links to cancer, also banned or restricted seven other chlorinated insecticides (dieldrin, kepone, mirex, lindane, aldrin, chlordane, and toxaphene). Because of suspected damage to wildlife, Germany, Italy, and the Netherlands have limited the use of the chlorinated herbicide atrazine, although it is widely used as a broad-spectrum agricultural weed killer in the United States. Many individual cities in Germany and Austria have banned the use of PVC plastics, which release dioxins when burned. And for one group of chlorinated compounds there is worldwide agreement: chlorofluorocarbons (CFCs) are being phased out under the Montreal Protocol, the international agreement designed to reverse destruction of the earth's protective ozone layer.

Toward Faster Action

Given the problems linked to a number of chlorinated compounds and their tendency to persist in the environment, Greenpeace's Thornton maintains that the system EPA uses to evaluate their safety—thorough investigation and regulation of one compound at a time—is far too slow to protect humans and wildlife. Consider how the agency assesses the risk level associated with a pesticide. Under present policies, any company seeking to register or, as periodically required, reregister a pesticide must submit voluminous data on its toxic effects. These typically stem from studies in which rats and mice are fed the test chemical from birth, and from test-tube

assays such as the Ames test, which evaluates whether the chemical causes genetic mutations in bacterial DNA. In another required study, researchers evaluate the product's effect on the offspring of several generations of rats exposed to the chemical. Finally, registrants must submit data on what happens to fetuses of pregnant rabbits exposed to the chemical. For a pesticide, a field assessment of its environmental fate is also part of the review process.

Such registration proceedings typically take years. Beginning in 1989, for example, EPA started to reregister 800 active pesticide ingredients under tougher guidelines. As of this past April, it had completed the process for only 60 compounds. Companies have been allowed to sell all the products during this period.

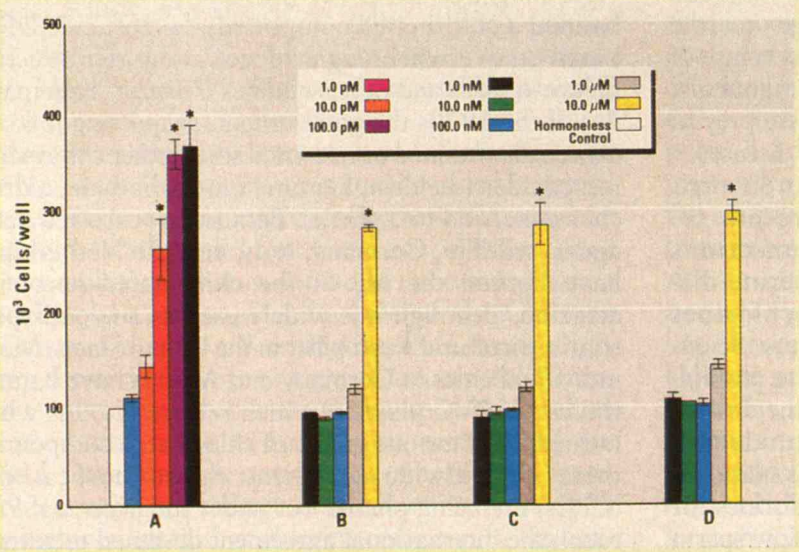
Like EPA's pesticide program, its regulation of pollutants discharged by industry into waterways is based on setting limits for individual chemicals—again, a bureaucratically complicated process. The agency now limits the discharge of 126 high-risk "priority pollutants," including chlorinated organic chemicals such as methylene chloride, typically used as an industrial solvent; nonchlorinated organics such as toluene, used as a solvent or for synthesizing other chemicals; and heavy metals such as cadmium, used as, for example, a heat stabilizer in plastics. EPA bases the discharge limits for each chemical on a "best available technology" study conducted for each industry that discharges the compound, and revises the studies every few years.

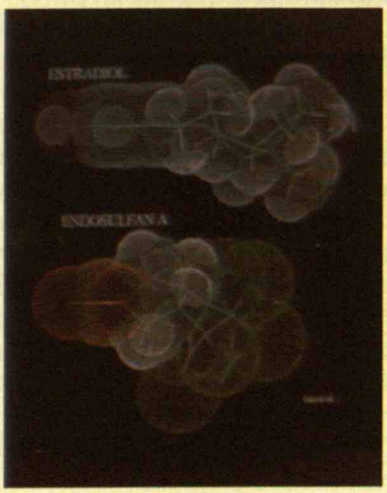
Unable to speed such evaluations by considering all chlorine compounds at once, the agency now prefers a middle course between industry and environmentalists: an interagency government task force to examine the environmental and health impacts of chlorine and chlorinated compounds and the availability, efficacy, and safety of substitutes. The proposed study would focus on four main uses of chlorine: water disinfection, solvents, polyvinyl chloride and other plastics, and pulp and paper manufacturing. EPA says it will then "develop a plan for any appropriate actions"—a result that could take several years.

Organizations desiring faster action could lobby to amend the Federal Insecticide, Fungicide and Rodenticide Act—which gives EPA authority to regulate pesticides—to allow the agency to restrict or even ban groups of chemicals, such as those in the chlorine family, if many members have known risk factors such as persistence and bioaccumulation. Such a change would require an escape clause for individual chemicals that do not pose significant danger.

Obtaining laws that give EPA broader authority to regulate whole classes of pesticides wouldn't be easy, however. Such proposals have surfaced many times on Capitol Hill, but, says Charles M. Benbrook, an environmental consultant in Washington, D.C., "nothing has ever been passed" because the issue "is so controversial" and unpalatable to industry. EPA's proposed study on chlorine-based chemicals could help proponents of a chemical-class amendment, however, by encouraging a public debate on the costs and benefits of chlorine technology and appropriate courses of action.

EPA could also make its regulation of chlorine compounds more effective by revising its general approach to risk assessment. Under its present policies, the agency estimates a chemical's abil-





Molecular structure may not predict whether a chlorinated compound such as the pesticide endosulfan A mimics the action of a female sex hormone like estradiol (left). But a test shows that three forms of endosulfan (columns B-D in graph) given in high enough doses cause human breast-cancer cells in cultured wells to reproduce almost as fast as cells exposed to estradiol (A). (The endosulfan doses range from 1 trillionth to 10 millionths of a mole—a unit based on the compound's molecular weight—per liter.) Researchers have also found such "estrogenic" effects when combining lower doses of endosulfan with small amounts of compounds that in larger quantities mimic estradiol.

DIAGRAMS: ANA M. SOTO AND CARLOS SONNENSCHEIN/TUFTS UNIVERSITY

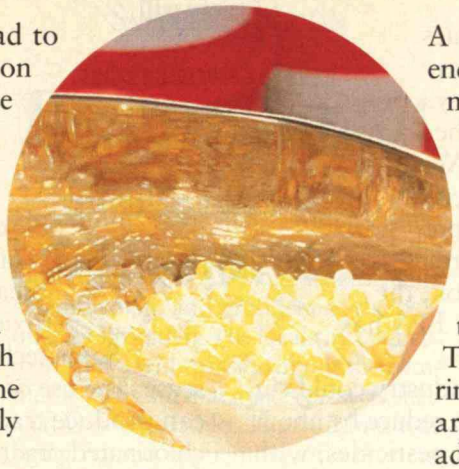
ity to cause cancer—which may lead to severe restrictions on use or a ban on export—by assuming that a high-dose response can be extrapolated to very small doses. This approach often overstates a chemical's risks because the dose-response curve may not be linear. In fact, as biochemist Bruce Ames of the University of California at Berkeley has suggested, the risk from a chemical toxic to animals at very high doses may drop to virtually zero at the trace levels at which the chemical is likely to be encountered in the environment.

EPA is now proposing changes to its cancer-testing guidelines that would, in effect, allow some "threshold" factors to be considered when evaluating cancer risks of pesticides submitted for registration or reregistration. Such a policy might reassign some chlorinated organics and other chemicals now labeled carcinogens into non-carcinogen or low-level-carcinogen categories.

The proposal would enable EPA toxicologists to consider the mechanisms underlying carcinogenicity rather than simply extrapolate from gross effects in laboratory animals. For example, under the new guidelines researchers might evaluate how a chemical interacts with the endocrine system to produce tumors, in the process finding that the compound produces tumors only when that system is malfunctioning. Richard Hill, science adviser in the Office for Prevention within the EPA branch that deals with pesticides and toxic substances, says that by emphasizing biological processes, the proposed studies would make it easier to evaluate the risks of chemicals tested on animals for humans.

Such a procedure would still require exhaustive animal tests of low doses of thousands of chemicals and is not as systematic as it could be. Most European environmental agencies have adopted a strategy EPA might do well to consider: screening compounds early in the review process to see if they harm cultured, cellular DNA. Positive results are almost always a red flag for the potential to induce cancer. Technicians then conduct animal tests of compounds testing positive and assume that those proving carcinogenic at high doses have similar effects at low doses. For products that do not harm cellular DNA, scientists conduct *both* low- and high-dose tests in animals to see whether threshold effects exist.

Certainly this testing would take some time. But it would be speedier than the present approach that subjects each chemical, regardless of its likely risks, to a full battery of tests.



If only to protect themselves from adverse publicity and possible future lawsuits, chemical manufacturers would do well to evaluate their slate of chlorinated products.

A quick-screening assay for the endocrine effects of persistent, bioaccumulative compounds would also be valuable. Ana M. Soto and Carlos Sonnenschein, cell biologists at Tufts University School of Medicine in Boston, have recently developed one such test. It is specific for estrogen mimics—compounds that simulate the effects of the female sex hormones. These mimics, which include both chlorinated and nonchlorinated compounds, are believed responsible for most adverse endocrine effects caused by chemicals in the environment.

In the assay, cultured human breast-cancer cells, which are estrogen-sensitive, are separately exposed to a natural estrogen and the chemical being tested. Technicians then compare the rates of cell proliferation in the two cultures. Test compounds that cause cells to grow as rapidly as natural estrogens are highly estrogenic and therefore could have significant effects. Soto reports that her assay results correlate well with observed estrogenic effects in rodents, with no false positives.

The assay could alert investigators to the need for follow-up trials in animals. Unfortunately, while well-established animal models exist for assessing acute toxicity and cancer, there are few standardized laboratory animal models for gauging suppression of the immune system, reproductive failures, and behavioral changes that specific chemicals may cause. Nor are there reliable ways of extrapolating the findings from such studies to humans.

What Industry Should Do

Meanwhile, even if only to protect themselves from adverse publicity and possible future lawsuits, chemical manufacturers would do well to evaluate their entire slate of chlorinated products to determine which they could replace now.

Precedent for such actions exists. For example, companies began developing substitutes for CFC refrigerants and plastics-processing aids as far back as the 1970s, when it became clear that these compounds posed an environmental threat and might eventually be banned. As a result, the mandated phaseout of CFCs has created minimum economic disruption for manufacturers of these products and their employees.

There is some evidence that industry is already pruning sales of certain marginal pesticides, both chlorinated

PHOTO: GEOFF TOMPKINSON / PHOTO RESEARCHERS INC.

and nonchlorinated. Many companies declined EPA's invitation to reregister pesticides in the late 1980s, points out Penny Fenner-Crisp, an EPA toxicologist. The lack of interest, she notes, followed EPA's disclosure of tougher—and more expensive—testing requirements than under previous registration procedures. And according to environmental consultant Benbrook, the number of pesticides registered with EPA has dropped by more than half since 1987.

Benbrook notes that the pesticide industry could cut back further. "It would be very easy to reduce by about two-thirds the use of chlorine-based pesticides, with only marginal impact on farmers," he says. He asserts that farmers could lower their chemical reliance by changing their tilling and cultivating practices, although this would require "a little more time." Recognizing the growing concern about chlorine, chemical manufacturers should also consider whether they could lower the overall production of other chlorinated chemicals.

And manufacturers who use chlorine in their production processes could consider shifting to alternative technologies. A case in point is the pulp and paper industry. Even though the standard paper-whitening process of chlorine bleaching is not yet prohibited, as proposed in the Richardson bill now before Congress, some companies have recently begun substituting other bleaching agents. One is chlorine dioxide, which, although chlorine-based, produces far lower dioxin levels than pure chlorine. Other manufacturers have switched to non-chlorine bleaches such as oxygen and hydrogen peroxide, which release no dioxins.

Society will have to determine what tradeoffs it is willing to accept as the chlorine controversy plays out.

Some technology changes, however, make little sense. The use of chlorine to disinfect water, although it can produce traces of chloroform and other harmful chlorinated organics, is one process that seems unlikely to change for now, since the system is cheaper and widely considered more effective than any alternative. Ozone, the water-disinfection technique cited by Greenpeace as a chlorine alternative, tends to dissipate more rapidly, requiring repeated treatments or follow-up treatments with some chlorine, according to EPA's Science Advisory Board. Moreover, ozone has been shown to form its own harmful products in water, including bromates, which are potent carcinogens. Society will clearly have to determine what tradeoffs it is willing to accept as the chlorine controversy plays out in legislative halls, corporate boardrooms, and the media. ■

THE HUMANE ENGINEER
SAMUEL C. FLORMAN

Destiny's Bait

As co-owner of a construction company, I have, through the years, attended a goodly number of groundbreakings, ribbon cuttings, and other assorted ceremonies. Politicians thrive on such events, and I have rubbed shoulders with many of them—including mayors, governors, members of Congress, and even one president (Lyndon Johnson at the opening of the Federal Pavilion at the New York City World's Fair in 1964). It used to be fun.

But I must confess that recently I've started to avoid these affairs whenever courtesy permits. There is a certain sameness to the proceedings, and the excitement has begun to wane. The launch of a new building is still thrilling, but the attendant ceremonies can be a bore. I am a contractor, and I build for a living. Like any other business enterprise, our company pursues profit—why should I care for tedious speeches that all begin to sound alike? At least that is the way my thoughts had been running.

But last spring something happened that changed my mind and, more important, refreshed my spirit. I was obliged to attend the ribbon-cutting ceremony for a housing project for indigent senior citizens, built by our company for a nonprofit community group in North Brooklyn. I say obliged because the organization's executive director, an effervescent woman of considerable persuasive powers, had met my wife at an industry dinner (another ritual I try to avoid) and extracted a promise that we would attend.

So there we were on a rainy June afternoon, crowded into the building's community room, along with the project's new residents, listening to speeches from officials representing all the various organizations that had made this building happen: the U.S. Department of Housing and Urban Development, which provided funding, the New York City Department of Housing Preservation and Development, and the New York State Division of Housing and Community Renewal. They were followed to the rostrum by the commissioner of the City Department of the Aging, with greetings from the mayor, and envoys from the local congresswoman, state senator, state assemblyman, and president of the borough of Brooklyn. The local city councilman spoke with passion about the community activism that makes projects such as this one possible. The building was being named in memory of a woman who for years had worked for the good of the community, and her family was present to accept a commemorative plaque.

Surprisingly, the long program, instead of having a soporific effect, began to take on an inspirational quality. How marvelous, I mused, that so many people and so many institutions had worked together for such a worthy cause. How different this project was from a bank or an office building, or even an apartment house for people who could afford to pay luxury rents. Human decency was built into the structure, along with the bricks; and happily our company was a party to what was being celebrated. Yes, we do work for profit, and to employ our professional talents; but that is far from telling the whole story. When engineering is applied to noble ends, the process is miraculously enhanced.

As I was thinking these thoughts, I heard my name called. The architect had been introduced, along with his design professionals, and now we the contractors were being thanked for our good work and cooperation. I looked at our project manager and construction superintendent, tough and talented individuals who apparently had melted with kindness whenever appealed to for help by the pro bono sponsors, and particularly by the elderly tenants when they moved in.

I found myself thinking of a novel I read some years ago: *Roll Back the Sea*, by the Dutch author A. Den Doolard. The book tells of the rebuilding of the dikes in Holland after their destruction during World War II. The story starts with the urgent needs of destitute people, and progresses through the work of politicians and design engineers. Finally, contractors appear on the scene, absorbed in estimating how much money they will earn from the project. But Doolard makes the point that their true purpose, whether they recognize it or not, is to play a vital role in this life-enhancing enterprise. As for profit, writes the author, "profit is merely the bait that destiny has offered to these calculators." Their greater reward is to be found in the accomplishment of work that allows people to lead better lives.

The bait that destiny has offered: what was true in Holland 50 years ago is equally true in Brooklyn today. It is good for engineers to be reminded now and again that their work, even when motivated directly by the prosaic needs of running a business, can nevertheless produce splendid results in the public interest. I think I will resume going to ribbon-cutting celebrations. ■

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PHOTO: L. BARRY HETHERINGTON

The Geography of Innovation

IT'S no secret that factories, stores, offices, and laboratories often locate in geographic clusters, rather than spreading out evenly across the map. The Clinton administration has turned the policy spotlight on this phenomenon, with its Technology Reinvestment Project. An important part of this project, called the Regional Technological Alliances (RTA), targets federal R&D contracts to consortia of companies, universities, and local governments that attempt to exploit their proximity to one another. The premise of such a policy is that places in which businesses buy from and sell to one another, and that share customers and suppliers, tend to innovate more effectively, and to grow more rapidly, than other locations. But the situation is a little more complicated than RTA seems to be acknowledging, raising questions about how well the money will be spent.

Social scientists and planners offer two possible explanations for the clustering pattern, each suggesting its own set of policy directions. Some companies seem to benefit by being located near others that make similar products. Thus we have steel-making districts, for example, and places where companies specialize in producing computers. RTA promotes such "localization." For other companies, however, a successful location is characterized by "urbanization"—that is, the presence of a broad mix of economic activities, including research labs, companies, and trade associations from a variety of industries, along with a dense fabric of social and cultural institutions.

Urbanization and localization need not be mutually exclusive. Los Angeles, for instance, has a rich mix of civic and commercial institutions along with a population practicing thousands of occupational skills: that's urbanization. But L.A. is also home to at least three highly concentrated industrial districts, focusing on entertainment, aerospace, and garment making.

Most regions tend not to be so balanced. Silicon Valley, microelectronics capital of the world, and Rochester, N.Y., the center of the U.S. optics industry, are examples of pure localization. Neither region can claim the diversity of occupations that one finds in Southern California. At the other pole, the downsizing of basic steel has left Pittsburgh with no particular industrial specialization; the region has become all amenity.

Empirical economists such as Edward Glaeser at Harvard and Vernon Henderson at Brown are now showing that innovation owes more to an area's urbanization than to any narrow industrial specialization. The cities that grow the fastest, and that adapt to changing economic climates, are those boasting diversity of information, institutions, and workers' skills.

My own research on innovation at individual companies and plants, conducted with Carnegie Mellon's Jon Gant and MIT's Maryellen Kelley, bears this out. The likelihood that managers of manufacturing enterprises will adopt new automation technologies rises significantly with a region's economic and institutional diversity—and depends not at all on the presence of same-sector clusters in the vicinity. The spread of innovation wisdom no longer comes about primarily from neighboring companies in the same industry swapping employees and peering over each others' shoulders but from access to firms in a broad mix of industries, and to institutions, such as universities and trade organizations, that dispense a wide variety of expertise.

The congressional Office of Technology Assessment is starting to study the relationship between innovation and location. If OTA's findings confirm the bulk of current research, the White House's technology policymakers will have to face up to the fact that too narrow an emphasis on regional specialization may be misguided.

For example, government financial and technical assistance to Southern California-based suppliers to the aerospace industry may fail to augment the growth of that sector—perhaps because the big aircraft companies continue to merge and move production overseas. In this case, though, because so much else is going on in that region, the assistance may nevertheless pay off—and thus deserve continuation—if some of those companies use the funding to develop their capabilities to join other local emerging industries, such as the design and manufacture of electric cars.

For long-run economic growth, it is becoming apparent that technology policies ought to encourage industrial collaborations within urbanized settings. These regions can sustain a broad array of businesses and occupations and allow local companies to weather the inevitable downturns in the fortunes of particular industries. The administration's Regional Technology Alliances are off to a good start. All they need now are more sharply focused criteria for placing their bets.■

PHOTO: L. BARRY HETHERINGTON

BENNETT HARRISON, a visiting professor of political economy at Harvard's Kennedy School of Government, is the author of Lean And Mean: The Changing Landscape of Corporate Power in the Age of Flexibility *(Basic Books).*

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AMY BRUCKMAN

Christmas Unplugged

Sometimes you've got to get away: an Internet aficionado leaves her virtual office behind and discovers the joy of the broken routine.

IF I had a network link, I'd be home now.

From my chaise lounge on the terrace of my parents' Miami Beach apartment, I see a grid of four-lane roads with palm-treed median strips, yachts moored on the inland waterway, a golf course, and a dozen tall white condominiums. The hum of traffic is punctuated by the soft thunk of racquets striking tennis balls somewhere below. The temperature is in the 70s and a breeze blows through my toes. I am a long way from Boston. If I had a net link, I'd know exactly how far.

I'd know the weather forecast for Miami, and, if I cared, for Boston too. Just about anything you might like to know is out there on the worldwide computer network—the Net—if you know where to look.

It's Christmas day in Miami, but I'm not sure it would really be Christmas or I would really be in Miami if I were plugged into the Net. I would be in my virtual office, a "room" in the text-based virtual reality environment where I do most of my work. I have a desk there, piled with things to do, and a fish tank—just like my "real" office. Except that the virtual fish don't need to be fed—they're just a program I created one day while procrastinating from real work. My virtual office is just some data on a computer housed at MIT that I can tap into from anywhere, but it is a place to me. When I log onto the network, I am there.

And I would be there right now, if not for a difficult choice I made two days ago. I was packed for my trip south and had called a cab. I had the important things: airline ticket, wallet, bathing suit. I stood in the hall staring at a padded gray bag, the one containing my Macintosh PowerBook computer. I grabbed the bag, double-locked the door, and started to walk down the hall. I stopped. I went back, opened the door, and put down the gray bag. I stood in the doorway, feeling foolish. The taxi honked. The honk gave me courage: I locked up again, leaving my computer—my office—behind.

A vacation should be about escaping from routines; going somewhere else provides a new perspective. But when I travel with my PowerBook, I bring many of my routines with me. I can readily gain access to all my familiar tools for finding information. It's as if I never left. And that's the problem. Had I brought my computer, I would not have written this essay (for which I am using a pencil). Instead, I would have logged onto the network and entered its seductive, engrossing world. By now I would have read the newswire and Miss Manners's column, answered a dozen questions from friends and colleagues, and possibly posted my thoughts on a movie I saw last night to a public discussion group. It would be as if I never left home.

The network destroys a sense of time as well as place. Daily and seasonal rhythms are subtle at best. As morning turns to evening, I am more likely to bump into my friends in Hawaii, less likely to encounter my friends in England. In the summer, things quiet down. April 1st is the only real network holiday—don't believe anything you read that day! Beyond that, life on the Net

ILLUSTRATION: SUSAN LEVAN

proceeds at an even, unpunctuated pace. There are no holiday decorations on the Net.

On my flight down here I saw a young boy carrying a sleek black bag on his shoulder. He held it naturally, but with a hint of importance. It took me a moment to see the logo: it contained his Nintendo Game Boy. His generation sees nothing remarkable about traveling at all times with a computer. It is already possible to connect to the network from a palm-sized computer with a cellular link. As computers get smaller and cheaper, we will lose even the excuse of the weight of that black bag or the cost of losing it.

The Net is becoming an important part of the lives of a broader segment of the population. Its spread presents a worrisome challenge: is it ever possible for us to take uninterrupted time off any more? The new technologies of connectedness are pushing people to blend their many roles into one: personal mail is mixed with professional correspondence, and work crises arrive on a cellular phone during leisure time. If our coworkers and competitors have made themselves perpetually available, we feel all the more pressure to do the same, lest we be left behind. One of my colleagues deliberately vacations in places so remote that getting a Net connection is almost impossible—it's the only way she can get a real break, and, for a little while at least, be a carefree newlywed instead of a world-renowned researcher. But such exotic locales are getting harder and harder to find.

I love the network and the people and places I find there. But sometimes I find it important to disconnect—to leave the cellular phone and the beeper in a desk drawer, leave that padded gray bag at home. To be out of touch, not for hours but for days. To leave behind routines, both virtual and real.■

AMY BRUCKMAN is a doctoral student in the MIT Media Laboratory and founder of MediaMOO, a text-based virtual reality environment for media researchers. Her e-mail address is asb@purple-crayon.media.mit.edu.

Reviews

BOOKS

THE LIMITS OF REGULATION

Contrived Competition: Regulation and Deregulation in America
by Richard H.K. Vietor
Belknap/Harvard, $35

BY STEPHEN D. SOLOMON

DELTA Air Lines recently announced it would eliminate 20 percent of its employees and slash annual operating costs $2 billion by 1997. United Airlines is preparing to give employees 53 percent ownership of the company in exchange for $4.9 billion in wage and productivity savings over six years. And American Airlines is grounding both planes and pilots in an effort to cut costs.

The goal of these three giants, which together carry about one-half of all domestic airline passengers, is to compete more effectively against Southwest Airlines, whose low fares enable it to quickly dominate every market it enters. While Southwest may be the immediate cause of their distress, however, the problems are far more deep-seated. Fully 16 years after the fact, the major carriers are still reeling from President Jimmy Carter's deregulation of fares and routes.

During the four decades of federal control that ended in 1978, operating efficiency excited no passion among airline chieftains. Why should it have? With federal regulation, fares were based on a rate of return above industry operating costs—a system that tolerated, and perhaps even encouraged, ballooning salaries and reduced productivity. High costs became embedded, and now that low costs and low fares rule the skies, companies have no choice but to take draconian steps.

High operating costs and the resulting high prices are among the hallmarks of industries dominated by government

regulation, says Richard H.K. Vietor, a business historian at the Harvard Graduate School of Business Administration. His new book, *Contrived Competition: Regulation and Deregulation in America*, profiles a company in each of four industries—aviation, telephones, natural gas, and commercial banking—that were brought under federal control during the New Deal and substantially deregulated in the 1970s and '80s.

The subject is one of the most important business and economic developments of the past half-century, and its lessons resonate for us today: some industries are still governed by extensive regulation, while others may come under federal domination in the future. Telephone and cable giants, for example, are snarling at each other like pit bulls, each claiming that their foes in the race to provide telecommunications and entertainment links to the home should be subject to more stringent federal rules.

Wise Hands in Washington?

Vietor's insights provide interested citizens and policymakers a foundation for analyzing the likely results of various schemes of regulatory control, though *Contrived Competition* seems oddly incomplete in some ways. For example, the profile of American Airlines and the airline industry ends in 1989, right at the start of a three-year period in which the industry lost in excess of $10 billion, more than the total profits it had earned in all the years since the Wright brothers flew at Kitty Hawk. Did American and its competitors overexpand during the 1980s? How much of their troubles were brought on by regulation and deregulation? Vietor does not answer those questions.

A question he answers quite well, however, is why the nation opted for regulatory control in the first place. Regulation, he reminds us, emerged from the nation's searing experience of the Great Depression and a widespread loss of faith in competition—or, as Hugh Johnson, head of the National Recovery Administration, succinctly put it, too much "eye-gouging, knee-groining, and ear-chewing in business." The solution was extensive federal supervision of key infrastructure industries. "High-quality, widely available service, secure contractual arrangements, and stable (often cross-subsidized) pricing were the principal objectives, and indeed accomplishments, of federal regulators," Vietor writes.

The faith that wise hands in Washington could guide key industries became frayed during the social and political eruptions of the 1960s and the economic decline that followed. As markets changed and problems engulfed each of the regulated industries, a wave of popular and academic support brought extensive deregulation. Important markets became more competitive than they had been since the 1930s.

Perhaps Vietor's most striking insight is the extent to which regulatory control breeds unstable market conditions. "Since the intent of economic regulation is to create conditions that would not otherwise occur, it is scarcely surprising that regulatory effects are eventually unstable, both economically and politically," he observes. He adds that advances in technology create much of the instability. Because regulators are either slow to adjust or simply lack the power to do so, the regulatory scheme

ILLUSTRATIONS: JON McINTOSH

eventually cracks, much as the California earth suddenly moves after years of invisible grinding below the fault lines.

The telephone market provides a telling example. In order to supply telephone service throughout the nation, regulators decided that long-distance charges should subsidize low rates for local service. By the time Congress passed the Communications Act of 1934, AT&T, operating under just such a system, was responsible for almost 100 percent of all long-distance service.

Over the next 40 years, Vietor notes, a number of technological innovations—including microwave relays, geostationary satellites, fiber optic cable, electronic switching, and various digital controls—brought down the fixed cost of long-distance transmission from $125 to less than $2 per circuit-mile. But because long-distance service continued subsidizing local phone lines, whose costs were rising, consumers did not enjoy such savings.

In this distorted pricing lay the "seeds of regulatory failure," Vietor concludes. One major problem was that the new transmission technologies opened the possibility of specialized telephone service. Microwave transmission, for example, was ready-made for point-to-point service between cities, and its modest capital costs lowered the barriers to entry in the long-distance market. In 1969, the Federal Communications Commission (FCC) approved MCI's application to provide microwave service for long-distance private lines, and six years later the company entered the market for traditional long-distance service. Required to absorb only a fraction of the cost of local phone service, MCI enjoyed a significant price advantage over AT&T.

Meanwhile, new technology such as inexpensive electronic components lowered the barriers to entry in the telephone-equipment market as well, and when the FCC lifted the prohibition against telephone equipment installed by customers, AT&T's Western Electric faced dozens of new competitors.

Technological change caused strains of similar magnitude for banking regulation. Vietor explains that "information processing and telecommunications capabilities dramatically affected the supply and demand for financial services and transaction products, and altered industry operations and structure." Out of the digital revolution came electronic transfer of funds, automated teller machines, point-of-sale terminals, and credit and debit cards. The use of mainframe computers and telecommunications favored the growth of large financial institutions that could spread their technology costs over many product offerings and far-flung geographic areas.

Using a loophole in the Bank Holding Company Act, nonbank companies—for instance, American Express, Merrill Lynch, and Sears Roebuck—began offering more and more banklike services. New financial products such as money market accounts, free from the interest-rate restrictions placed on banks, siphoned many billions of dollars out of the banking system. This, in turn, caused BankAmerica and other institutions subject to federal regulations to lobby, eventually with considerable success, for a lifting of many controls over the banking industry.

In the end, Vietor concludes, extensive government regulation of entire industries becomes untenable when it departs from the technological and economic realities of a dynamic marketplace. "Restrictions on entry, for example, cannot be maintained indefinitely if there are no significant economic barriers to entry," he writes. "To put it another way, regulation needs to work *with* market forces and technological progress, rather than *against* them."

Yet it is difficult to imagine how any scheme of regulation could easily coexist with market and technological forces for long. Vietor has drawn a portrait of a seemingly irreconcilable conflict: dynamic marketplace and technological forces on the one hand, and vested political and economic interests resisting change on the other.

Regulatory schemes, as Vietor has painted them, seem to have a natural lifespan. They begin with a widespread recognition that open competition must be constrained for some greater good. Regulation may actually accomplish those purposes for some years, but the end seems almost preordained: an explosive fury of change as pent-up market and technological forces are finally set free.■

STEPHEN D. SOLOMON, an associate professor of journalism and mass communication at New York University, is a business writer who has served on the staffs of both Inc. *and* Fortune.

BOOKS

TECHNOLOGY ON THE DRAG STRIP

High Performance: The Culture and Technology of Drag Racing, 1950–1990
by Robert C. Post
Johns Hopkins University Press, $35.95

BY JOHN WILKES

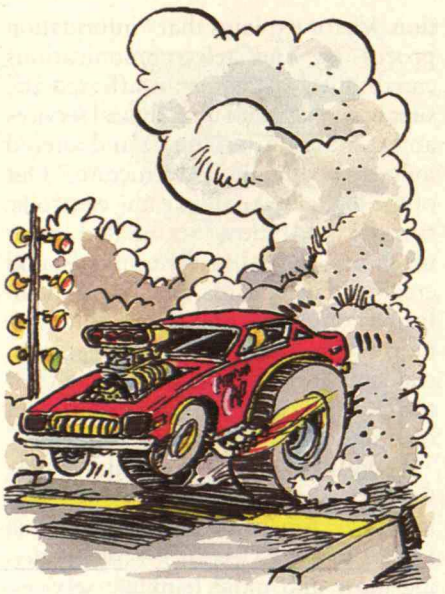
WHEN I was in high school in Walnut Creek, Calif., in the late 1950s, if you weren't a fighter, a lover, or a mechanic, you were nothing. The best mechanics were hot rodders—it was the only way you could properly learn to "wrench"—and the best hot rodders were usually good with their fists, too. They also became lovers: beautiful girls seemed to come with the territory.

Walnut Creek's Jim Baca was the supreme example of the type. Every Saturday evening Baca, impossibly mature at 21, would roll into town in his red-and-cream '55 Chevy Bel Air hardtop, just back from a drag strip. Under the hood, we all knew, two four-barrel carburetors sat atop a thoroughly souped-up Chevy V-8. On the Chevy's rear side windows, crudely daubed with white poster paint, was his racing number, 169, and class designation, "C/G" (the "C" stood for class, the "G" for "gas"—that is, a modified engine or driveline).

He would pull slowly into Mel's, the

local drive-in restaurant, hunched over the wheel, goosing the throttle to keep the balky engine running. Then he would park, lean back, and wait squinty-eyed and stone-faced for the car hop, his left arm hanging down the side of the door. Sometimes his knuckles would be decorated with dried blood. Did a wrench slip? Did he slug somebody? He never said. His dark-haired 17-year-old girlfriend would be beaming up at him, barely noticing the respectful guys and other worshipful girls in the rows of parked cars around them.

The drag strips Baca and other hot rodders frequented welcomed all comers, and in 1958, when I started my senior year, four strips lay within an hour or so of Walnut Creek, in different directions. You could simply drive to one, pay an entrance fee of a few dollars, get your number and classification



painted on your side windows, and wait your turn in the morning time trials. Your objective was to accelerate from a standing start as quickly as possible and run through the timing lights, which everyone called the "eyes," a quarter mile down the track. Afterward you were handed a slip of paper with two numbers handwritten on it. One, your "elapsed time," was how many seconds it took you to get to the end of the quarter mile, and the other was your speed at that point. (My own '51 Oldsmobile coupe, also classified as "gas" owing to a '37 LaSalle floorshift transmission, turned a decidedly uncompetitive speed of 80 and elapsed time of 16.1 seconds.)

A high top speed conferred status, but the elapsed time was more important, for it determined who would compete against whom in the afternoon "elimination" races, which began with leisurely runs by cars in the slowest stock classes and ended with a duel between two thundering, fire-and-smoke-belching dragsters. The cars would come up to the starting line two by two, and the starter, who stood between them, would point his flag at one, then the other, then theatrically leap into the air amid the smoke from the spinning tires. All afternoon the sweet smell of nitro and alcohol fuel hung in the air, a pleasant accompaniment to the stupefying noise.

Robert C. Post, editor-in-chief of the distinguished scholarly journal *Technology and Culture* and a curator at the Smithsonian Institution's National Museum of American History, was also part of the 1950s drag racing world. "I cobbled together drag racing machinery in my parents' driveway," he writes in his new book, *High Performance: The Culture and Technology of Drag Racing, 1950–1990*. "To their horror, had they known, I regularly participated in unlawful street races. . . . I had driven some pretty strong machinery in street trim, prewar Ford coupes; the best could turn 100 miles per hour in the quarter mile, with elapsed times around 14 seconds, and, believe me, that kind of acceleration got your attention." As a former practitioner, Post is intimately familiar with the sport's technology, and keen in his observations of the male and female drivers and mechanics. Coupled with his impeccable credentials as a historian of technology, that background makes him uniquely qualified to investigate the phenomenon of drag racing.

Why Be Normal?

In the late 1950s, as Post meticulously documents, the fastest speeds dragsters reached were in the 180s. The quickest elapsed times were between eight and nine seconds. Some dragsters got such poor traction that they spun their wheels for the entire quarter mile, "smoking the tires right through the eyes," as the drivers liked to say. By contrast, dragsters today are getting excellent traction and putting twice as much power on the road, reaching speeds of over 300 miles per hour in the standing quarter mile and covering that ground in less than five seconds.

Already in the 1970s the fastest dragsters were generating too much power for many of the small, makeshift drag strips that dotted the United States. Accidents were killing drivers by the dozens. Clutches and transmissions "grenaded," brake parachutes failed to open, and blown engines sparked conflagrations of fuel and oil, among other hazards. Nearly all the small drag strips simply closed

down during the 1960s and '70s rather than try to meet the financial and technical challenges presented by the faster cars. Larger, better-equipped strips with guard rails and more space for deceleration have taken their place, but they are few and far between, so that small-town high school kids running their own street machines are now a rare breed.

During these later years, and especially during the 1980s, television and deep-pockets sponsors, mainly in the tobacco industry, discovered the sport and commercialized it. Theatrical performance became as important as mechanical performance when the so-called funny cars—colorful, shatteringly powerful fiberglass-bodied coupes that faintly resemble late-model production cars—began to achieve speeds and elapsed times comparable to those of the single-seat dragsters.

Post's rendering of all these developments is precise and engaging, and along the way he takes issue with some cherished notions held by historians of technology. One is that machinery evolves inevitably in the direction of greater efficiency. Pointing out that efficiency is devilishly hard to pin down, he argues that the role it plays in a technology's development is not always central—and that individual people with their idiosyncratic leanings exert far more influence than is generally recognized. He notes, for example, that the "mid-engine" dragster configuration, in which the engine is between the driver's back and the rear wheels, was tried and, despite its promise, abandoned in the 1960s in favor of the radically different "slingshot" design, in which the driver sits astride the driveline, cantilevered behind the rear wheels for greater traction. When the oft-injured champion Don Garlits resurrected the mid-engine dragster almost 20 years later, it was chiefly for safety reasons. Clutches and transmissions can blow up in drag-racing accidents, and with the slingshot design, they were blowing up between the driver's legs. Engines exploded as well, spewing burning fuel and oil into the driver's face. Without Garlits's interest in enhancing his own safety, most dragsters would probably be slingshots today.

Post also calls into question the prospect of economic gain as a force motivating technologists. He points out that sheer technological enthusiasm—the joy of innovation for its own sake—has produced a bewildering variety of drag-racing vehicles, some of them downright absurd: twin-engine cars, three-wheelers, cars with engines mounted sideways, a four-wheel-drive dragster powered by four Buick V-8s, and even dragsters powered by jet aircraft engines. Some of these cars have had little chance of dominating their class, yet the ingenuity they show has earned their builders great respect among their peers. Summing up the general attitude, one such racer has sported the motto "Why be normal?"

Technological enthusiasm has sometimes led to excess, Post concedes. When a car builder has gone too far—developing a rocket-powered dragster, for example, or using too-volatile fuels, or building in jacks to raise a vehicle's rear wheels off the ground for a quicker start—drivers and the rule-making body of the National Hot Rod Association have usually agreed to ban the innovation. The NHRA has even outlawed computers from race cars—that is, for any purpose other than taking data. Officials and drivers alike feared that dragsters could become virtual robots, leaving the driver with nothing to do but hang onto the steering wheel.

As Post deftly guides the reader through four densely packed decades and his own cogent and persuasive analysis, his relish for the subject matter is unabashed. What's more, his prose is vigorous and tidy, and his research—bodied forth in 83 pages of appendices, annotated bibliography, and index—is not likely to be surpassed. Staking out a technological fringe area, *High Performance* offers a truly memorable scholar-enthusiast's view of the bond uniting human beings and the machines they build. ■

JOHN WILKES is a senior lecturer and director of the graduate program in science writing at the University of California, Santa Cruz.

CONTINUED FROM PAGE 8

AUTOMATONS WHO THINK

I applaud Mitchel Resnick's examination of the decentralized characteristics of seemingly centrally organized systems in "Changing the Centralized Mind" (*TR July 1994*). A crucial distinction should be made, however, between decentralized systems composed of "auto-responsive" actors such as ants and slime-mold cells versus those involving humans, who think and have preferences. People's responses to simple rules and incentives, in particular, are much less deterministic than those of lower-order entities. The assumption that human economic actors can be treated as automatons in part explains the failure of mechanistic models of the economy that view it as an engine that can be managed by a central authority. It would be unfortunate if we did not learn from this erroneous assumption as we explore the dynamics of decentralized systems.

GREGORY DEMERS
Redwood City, Calif.

PROSTATE UPDATE

In "Screening for Prostate Cancer" (*TR August/September 1994*), P.J. Skerrett failed to mention that the PSA test can be ambiguous. I am one of those whose PSA numbers bounce up and down, yet periodic exams and two sets of biopsies 18 months apart have never shown cancer. My PSA number has twice been reduced sharply by taking antibiotics, indicating the masking effect due to infection. Thus, PSA testing cannot, by itself, provide unambiguous information of prostate cancer. Rectal examination and prostate biopsy are necessary tools for definitive cancer screening.

WILLIAM L. RICE
Fairfax, Va.

P.J. Skerrett is out of touch with current standards of treatment. On August 29, 1994, the FDA finally approved the PSA test in conjunction with a digital rectal exam as an effective diagnostic tool for detecting prostate cancer. The PSA is a simple blood test that may or may not indicate the presence of cancer. It often indicates benign prostate enlargement. At the very least it provides a baseline for future observation. Whether to intervene surgically or with radiation is never based on a PSA test alone. A digital rectal exam by a urologist may detect small tumors.

An outpatient biopsy would be a logical next step. Depending on the aggressiveness of any cancerous cells found—as measured by the Gleason score—the patient might then undergo a bone scan and a CT scan to rule out detectable metastasis.

In mentioning the hazards of surgery and radiation therapy, the article neglected to mention nerve-sparing prostatectomy, a surgical technique that reduces the chance of such complications as incontinence and impotence. The procedure has been used for about a decade and is practiced at the larger medical centers.

JUDITH BERG
Buckfield, Maine

A PSA screening prompted a biopsy verifying my prostate cancer three years ago. Then 62, and in otherwise excellent health, I was treated by prostate cryoablation, a minimally invasive surgical procedure that involves freezing the prostate with liquid nitrogen. Cryoablation justifies PSA testing for men not willing to accept the risks of either radical prostatectomy or radiation therapy—it offers the promise of destroying cancer while maintaining quality of life. Cryoablation can be repeated if localized cancer remains, and recuperation is rapid. I was back at the office in less than a week. Incontinence is rare except in some cryoablation patients who have already failed radiation. Impotence appears to occur less often with cryoablation patients under 60. Today about 80 hospitals offer this procedure. Readers can obtain more information from Patient Advocates for Advanced Cancer Treatment at 616-453-1477.

MORLEY KAHN
Greenwich, Conn.

INCREMENTAL ADVANCES ADD UP

In "Air Power Comes of Age" (*TR August/September 1994*), David Callahan notes that 50,000 bombing runs against German-controlled oil refineries during World War II cut production by only 60 percent. But he fails to mention that during the bombing of Japan, the 315th bomb wing introduced the B-29B, an ultralong-range version of the aircraft. Black-painted and having no gun turrets except for the radar-directed rear cannon, the B-29B was equipped with a new high-resolution bombing radar (the APQ-7). No mission involved more than 130 aircraft, but in less than three months the 315th destroyed all of Japan's refineries. This is an oversimplified comparison but it does suggest that incremental improvements in weapons and tactics can make qualitative and totally unexpected differences in results. Our enemies have achieved similar fearsome advantages through almost trivial upgrades of old technology (e.g., by equipping diesel submarines with snorkels.)

BEN Y. MASON
El Paso, Tex.

COMPUTER-GENERATED TESTIMONY

In "Simulations on Trial" (*TR May/June 1994*), Arielle Emmett falsely implies that computer-generated animations used in court are the equivalent of testimony, maintaining that "animations [should] tell the truth, the whole truth, and nothing but the truth—just like any good witness." But, like charts, graphs, and photographs, computer-generated animation is demonstrative evidence. Such evidence is prepared specially to illustrate other evidence, whether real (an object like a gun or document) or testimonial. The principal use of a computer-generated animation is to illustrate the testimony of an expert witness. After the side presenting the expert qualifies him or her to express an opinion, the expert clarifies that opinion by way of a computer-generated animation, essentially a series of charts. Emmett's error is understandable, since even judges and lawyers have trouble articulating the rules relating to demonstrative evidence.

HAROLD L. BURSTYN
Mt. Vernon, N.Y.

STATISTICS MISUSED

In "How Numbers Can Trick You" (*TR October 1994*), Arnold Barnett has addressed an important topic and aptly illustrated several ways in which statistics can be misused. However, in analyzing the difference between "likelihood" and "odds" in relation to the U.S. Supreme Court ruling *McClesky v. Kemp*, he chose numbers that are as subtly misleading as any in his article.

His example concerns the probability that a defendant would be sentenced to death if the victim were white (PW) and the probability that a defendant would be sentenced to death if the victim were black (PB). According to Barnett, a statistical study of death sentencing in Georgia found that the odds of a death sentence in a white-victim case (i.e., PW/(1-PW)) were 4.3 times the odds in a black-victim case (PB/(1-PB)). However, the study was said to be misinterpreted as meaning that the probability of a death sentence was 4.3 times higher in the case of a white victim than in the case of a black victim—that is, that PW=4.3 PB.

To demonstrate the discrepancy between these interpretations, Barnett chose a value of PW =0.99 and calculated that PB=0.96, hardly a factor of 4. But how realistic is the assumption of a 99 percent probability of being sentenced to death in any trial, regardless of the color of the victim? Suppose instead that PW=0.2. Now using the correct equation PB is 0.05, for a factor of 4. If PW=0.5, then PB works out to 0.19. In fact, PW is at least twice the value of PB as long as PW is 70 percent or less.

By choosing an extreme of PW=0.99, Barnett marginalized the study. Although he complained that the misinterpretation "greatly exaggerated the general understanding of the degree of disparity [in sentencing based on the victim's race]," his own analysis selectively understated this disparity.

TED TSOMIDES
Center for Cancer Research, MIT

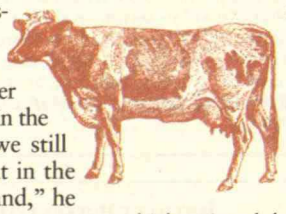
Classifieds

Phenomena

By David Brittan

And Now the Farm Report

Auburn, Ala. ❧ James Edwards, the fastest-talking Southerner ever recorded in a phone interview, is all het up about the latest miracle material of agriculture. "You get me wound up on this and you have a hard time slowin' me down," he says. The new marvel that occupies his life as a soil scientist for the USDA's Agricultural Research Service, and excites him to the point where syllables crowd each other out like hogs at feeding time, is wastepaper. Tons of it. Shredded and compressed into sausage-sized pellets, says Edwards, old telephone books and newspapers can work wonders on croplands. For starters, the pellets, spread on or near the surface of the soil, control erosion like nobody's business. In a recent five-month test, corn fields lost 30 percent less topsoil with Edwards's pellets than with the next-best method, "no-till," where farmers plant directly into the residue of the previous crop. Paper pellets could be a boon to the Southern Plains, where half the cropland is rated highly erodible and farmers are scrambling to comply with the anti-erosion provisions of the Food Security Act of 1985. The pellets also retain water, keeping the soil so moist that cotton becomes ready for harvest a month early, and they insulate soil from changes in temperature. As if that weren't enough, paper pellets act indirectly as fertilizer. While devoid of plant nutrients themselves, the pellets provide carbon for soil microbes to munch on; the microbes multiply, fixing nitrogen from the soil in the rooting zone, where it becomes available to plants instead of leaching away. Watch—next Edwards will be claiming that paper can replace chemical weed killers. "In north Alabama we have a plot yielding a healthy 40 or 50 bushels of beans per acre without herbicide," he says. There, you see? A likely explanation, says Edwards, is that for the first three or four weeks after pellets are applied, fast-growing soil microbes corner the nitrogen market, and weed seeds, being particularly dependent on nitrogen, fail to thrive. The weeds never rebound. "We give the crops a head start," says Edwards, "and then they grow a canopy that shades everything else out." Although Edwards believes more field testing and market research are needed before the pellet process can be commercialized, he is aware that he may be sitting on the solution to a large part of the nation's solid-waste disposal problems. "I think agriculture could utilize every ton of paper that's being generated in the country today, and we still wouldn't make a dent in the total acreage of cropland," he says rapidly.



Ithaca, N.Y. ❧ If you run out of wastepaper to fertilize your plot, perhaps you would care for a truckload of fish parts. Joe Regenstein, a food scientist at Cornell University, and Susan Goldhor, director of the New England environmental organization Center for Applied Regional Studies, have produced a video explaining how to compost the waste from fish processing. The technique is similar to conventional composting: fish heads, tails, and innards join plant waste in a primordial heap that decomposes into humus. Regenstein and Goldhor hope to promote composting as an alternative to dumping fish parts in landfills, which is what New England processors do with much of the 250,000 pounds of waste they generate each week. The tape will be available soon from the National Fisheries Institute in Arlington, Va.

Philadelphia, Pa. ❧ Meanwhile back at the dairy, a USDA research chemist has found a way to convert cow's milk into an infant formula that may be the closest thing yet to mother's milk. Bovine milk and most commercial formulas contain a type of protein (beta-lactoglobulin) that many babies are allergic to, says John Woychik, the recently retired head of dairy research at the USDA's Eastern Regional Research Center. Not only that, but "human milk has a nice soft curd [solid component], readily digested in the infant's stomach, whereas cow's milk tends to form a very hard curd." Woychik's solution is to cool cow's milk to a few degrees above freezing, at which point alpha-S casein, the protein that forms hard curds, separates from gentler forms of casein and can be filtered out. The addition of a little salt separates out the allergenic protein as well. Treated cow's milk might cost slightly more to produce than today's formulas, says Woychik, but its mildness "should be worth a few cents' premium."

Cambridge, Mass. ❧ Daniel Lieberman, a junior fellow in the Department of Anthropology at Harvard University, has some thoughts on how the whole glorious enterprise got started—agriculture, that is. It's generally accepted that the Natufians, an ancient people of the southern Levant (today's Israel and Jordan), were the first to give up hunting and gathering for farming, some 10,000 years ago. But, says Lieberman, "most people assume that the hunter-gatherers became sedentary only after they began food production. More likely, agriculture was a *consequence* of hunter-gatherers becoming sedentary." A key piece of evidence is the dental remains of the gazelle—the Big Mac of the Ice Age, as Lieberman calls it. He says the mineral content of the gazelle's tooth surfaces reveals whether the animal was killed in the nutritionally rich summer or the lean winter. With the expiration date of each gazelle clearly labeled, Lieberman has determined that up until about 12,000 years ago Natufian tribes rarely feasted on the same spot for more than one season; they would roam the highlands in the summer and the lowlands in the winter. "Then bang, 2,000 years before agriculture, you start finding sites in which they're eating gazelle all year long," he says. Lieberman speculates that Natufians became homebodies because of the sudden dry period that hit the Middle East at the end of the Ice Age, forcing tribes to compete for resources in a smaller fertile area. At that point, he says, territorialism would have set in, requiring people to stay in one place to protect their turf. Why might agriculture have followed? "Because if you're a hunter-gatherer and you're not mobile, you're eating yourself out of house and home." As they depleted their environment over the next 2,000 years, the Natufians resorted to hunting rabbits, turtles, lizards, and other small critters. "Under those conditions," says Lieberman, "it may simply have been easier to be an agriculturalist."

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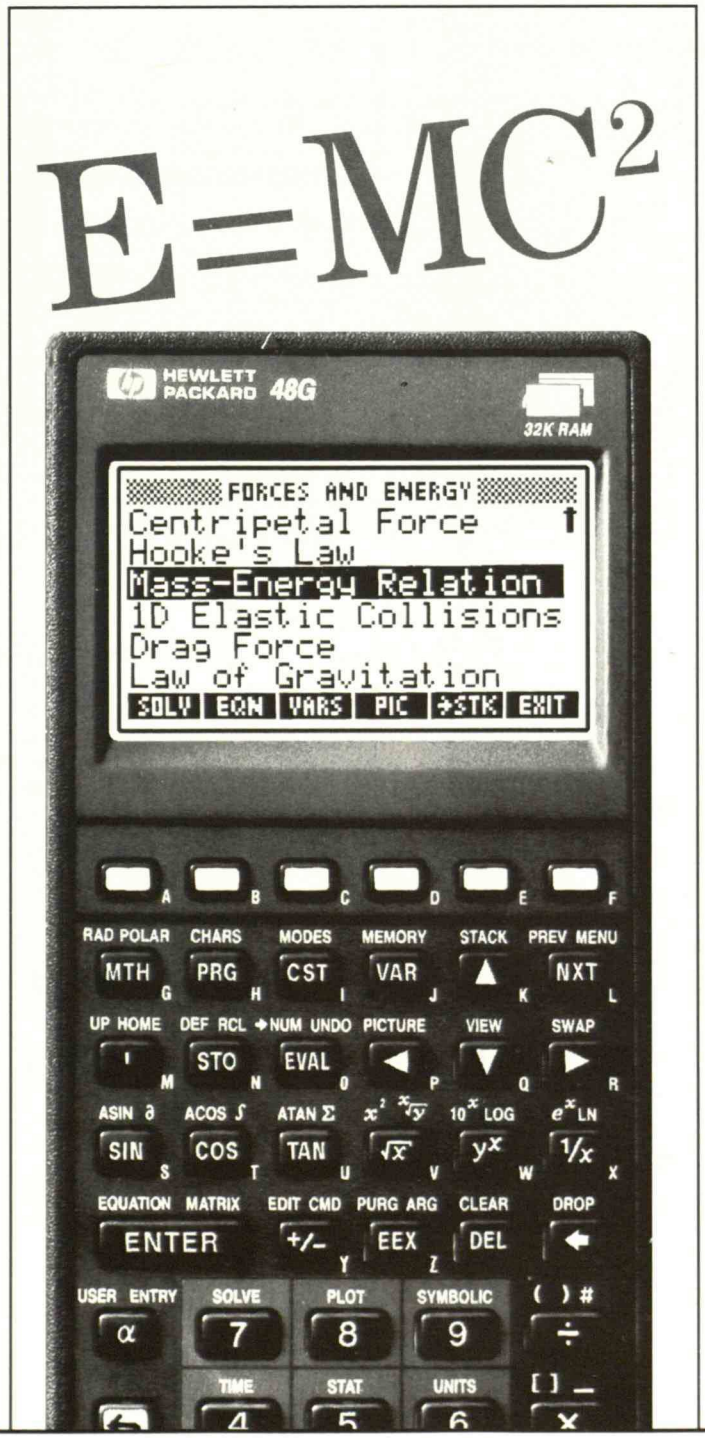

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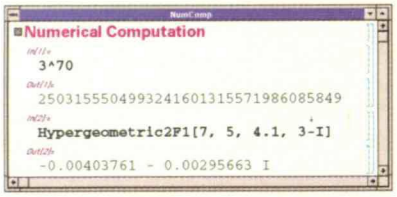

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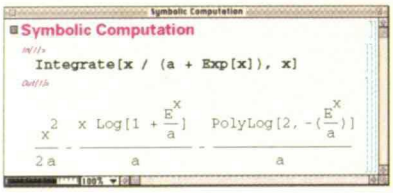

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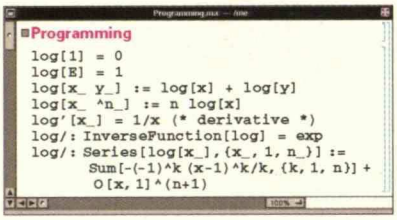

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